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OF

NATURAL PHILOSOPHY, CHEMISTRY, AND THE ARTS.

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A JOURNAL OF NATURAL PHILOSOPHY, CHEMISTRY, AND THE ARTS:

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BY WILLIAM NICHOLSON.

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V. An eaſy Method of Cleaning and Bleaching Copperplate Impreſſions or Prints, extracted from a Letter of Sig. Geo. Fabbroni, Sub-director and Superintendant of the Royal Cabinet of Philoſophy and Natural Hiſtory of his Royal Highneſs the Grand Duke of Tuſcany, to Sig. D. Luigi Targioni at Naples — — — — p. 265

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VI. On the Propagation of the Zebra with the Aſs — — p. 267

VII. On the Proceſs of Bleaching with the Oxygenated Muriatic Acid; and a Deſcription of a New Apparatus for Bleaching Cloths with that Acid diſſolved in Water, without the Addition of Alkali. By Theophilus Lewis Rupp — — — — — p. 268

Experiments which prove that the uſual addition of alkali to the bleaching liquor impairs its power. Apparatus for performing the proceſs without alkali; by which a ſaving of forty per cent. is gained.

VIII. Experimental Reſearches concerning the Principle of the lateral Communication of Motion in Fluids, applied to the Explanation of various Hydraulic Phenomena. By Citizen J. B. Venturi, Profeſſor of Experimental Philoſophy at Modena, Member of the Italian Society of the Inſtitute of Bologna, the Agrarian Society of Turin, &c. (Continued from p. 179) — — — — — p. 273

Experiments on the quantity and limits of the increaſed expenditure of fluids through conical divergent tubes.

IX. An Account of the Means employed to obtain an Overflowing Well. By Mr. Benjamin Vulliamy — — — p. 276

A well of four feet diameter was ſunk and ſteined to the depth of 236 feet, and then bored, and a copper pipe of the diameter of 5¼ inches driven through 21 feet. Water and ſand roſe through 96 feet.

96 feet. The water was drawn off, and the ſand dug out, till only 36 feet remained; when ſand and water again ruſhed in to the former height. The current of water was then continued by pumping, and part of the ſand raiſed through the water by heavy valve buckets. During this laſt proceſs the water gradually roſe and increaſed in quantity ſo as to overflow the top at the rate of 46 gallons per minute.

Scientific News, and Accounts of Books — — p. 279

Compoſition for extinguiſhing fire.—Travels in Africa by Mr. Mungo Park.—Proceedings of the African Aſſociation—Account of Mr. Park's route and diſcoveries.—Table for reducing Engliſh meaſures and weights into French.—Table of the prices of neceſſaries, day-labour, &c. ſince the Conqueſt. By Sir George Shuckburgh Evelyn, Bart. F. R. S. and A.S.

OCTOBER 1798.

Engravings of the following Objects: 1. The Art of Speedy and Swift Intelligence. 2. Sir R. L. Edgeworth's Portable Telegraph.

I. Curious Circumſtances upon which the Vitreous or the Stony Characters of Whinſtone and Lava reſpectively depend; with other Facts. In an Account of Experiments made by Sir James Hall, Bart. F.R. and A.S.S. Edin. — — — — — — p. 285

Objection to the igneous formation of whinſtone or baſaltes, which by fuſion affords glaſs. Diſcovery that the vitreous character is owing to ſpeedy refrigeration, and that the ſtony character with a leſs degree of fuſibility is afforded by ſlow cooling. Valuable inductions, with a table of the reſults of experiment.

II. On the Analyſis of Pumice, which is found to contain Potaſh; and of Baſaltes and Lava, containing Soda. By Dr. Kennedy — p. 289

III. Experiments and Obſervations on the Preparation, and ſome remarkable Properties, of the Oxygenated Muriate of Potaſh. By Mr. Thomas Hoyle, jun. — — — — — p. 290

Preparation of the oxygenated muriate of potaſh, and its ſolution in water and acids. Effects of light and heat. Detonation with a great number of combuſtible ſubſtances with the ſalt by friction and the acids.

IV. Obſervations on the Natural Hiſtory of Guiana. In a Letter from William Lochead, Eſq. F.R.S. Edin. to the Rev. Dr. Walker F.R.S. Edin. Regius Profeſſor of Natural Hiſtory in the Univerſity of Edinburgh. p. 297

Coaſt of Guinea. Striking appearance of the ſky—within the tropics. Winds, dews, fogs, and temperature. Face of the country. Deſcription of the Savannahs.

V. On the Sugar Maple. By Citizen Teſſier — — p. 304

Accounts of the climate moſt favourable to the growth of ſugar-maple trees. Method of obtaining the ſaccharine juice. Hiſtorical facts. Quality and quantity of maple-ſugar produced in Canada. Inſtructions for introducing this tree into Europe. Probable advantages. Dr. Ruſh's account of the manufacture of maple-ſugar in the weſtern countries of America.

VI. The Progreſs of Mechanical Diſcovery, exemplified in an Account of a Machine for cutting Files. (W. N.) — — p. 309

Chemical and mechanical purſuits compared. The greater number of new machines are of no value. Difficulties of carrying inventions into effect. Progreſs. Machine for cutting files. General remarks.

VII. The Dutch Proceſs for making the Blue diſtinguiſhed by the Name of Turnſol — — — — — p. 311

VIII. Experiments and Remarks on certain Ranges of Colours hitherto unobſerved, which are produced by the relative Poſition of plain Glaſſes, with regard to each other. (W. N.) — — — p. 312

Short ſtatement of Newton's doctrine of the fits of reflection and tranſmiſſion of light. Subſequent experiments. A new ſeries of colours formed between plain glaſſes; different from but coexiſtent with the Newtonian, and much leſs affected by changes of temperature, poſition, or electrization. This effect is produced when the plates are at conſiderable diſtances from each other; for example, four feet. Other facts.

IX. Some Account of the Country and Climate of the North-weſtern Lakes of America. By Major C. Swan, Paymaſter to the Weſtern Army. p. 315

X. An Eſſay on the Art of conveying Secret and Swift Intelligence. By Richard Lovell Edgeworth, Eſq. F.R.S. and M.R.I.A. — p. 319

Deſcription of the French Telegraph, and that of Robert Hooke. Late trial of Hooke's method. Deſcription and uſe of an apparatus for ſpeedy and ſwift communication by numbers. It ſuperiority over the alphabetical telegraph. Carried into effect acroſs the Iriſh Channel.

Scientific News, and Accounts of Books — — p. 328

Mr. Park's Travels in the unexplored Parts of Africa — — p. 329

NOVEMBER 1798.

Engravings of the following Objects: 1. Leaf, Acorn, and Prickly Cup of the Turkey and Spaniſh Oaks. 2. A new Eſcapement. And, 3. An Apparatus for ſaturating the Alkalis with Carbonic Acid.

I. An Account of three different Kinds of Timber Trees, which are likely to prove a great Acquiſition to this Kingdom, both in point of Profit, and as Trees for Ornament and Shade. By Charles White, Eſq. F.R.S. p. 333

Hiſtorical

Historical facts and observations, which prove the rapid growth and advantages to be derived from the broad-leaved American black birch, the Athenian poplar, and the iron, wainscot, or Turkey oak.

II. Abstract of a Memoir of M. Proust, on the Tanning Principle. By Citizen Descotils — — — — — p. 337

The solution of muriate of tin precipitates the tanning principle from a decoction of nut-galls, and leaves the acid of galls in solution. Methods of obtaining the gallic acid and the tanning principle separate from each other. Precipitate of glue with tanning. The green sulphate of iron is not precipitated by either of the principles of galls. Difference of the precipitates of the red sulphate by those principles. Application of the facts to the process of dyeing black.

III. Notice of a Memoir of Citizen Guyton, upon the Tables of the Composition of Salts, and the Means of verifying the Proportions indicated by those Tables — — — — p. 340

When two salts, differing in their acids and their bases, are of such a nature as to change their principles by double elective attraction, as for example, the sulphate of potash and nitrate of lime, it is known that two new salts are formed; namely, in the present instance, nitrate of potash and sulphate of lime: but the quantities of each base, sufficient to produce neutral salts in the first combinations, are not the same as will saturate the acids in the new compounds. If, therefore, the quantity of one salt be such as to afford enough of its base to saturate the acid of the other, the base of this last will be either more or less than is sufficient to saturate the acid of the first-mentioned salt. In this case, it may be inferred, that one of the new compounds will be neutral, and the other not so. But the facts refute this conclusion; for the mixture shews no redundance of either principle. Why this happens is a new and interesting chemical theorem.

IV. On Pasigraphy; or, the Art of Writing which shall be intelligible to all Nations — — — — — p. 342

The universal writing is not the means of rendering all languages intelligible to all nations; in its own nature it supposes the existence of one common language proposed to all nations for their acceptance and use. History of the attempts and observations of various eminent men; Lord Bacon, Des Cartes, Becher, Dalgaru, Frischius, Kircher, Besnier, Wilkins, Leibnitz, De l'Epée, and Condillac. General remarks.

V. Observations on the Natural History of Guiana. In a Letter from William Lochead, Esq. F.R.S. Edin. to the Rev. Dr. Walker, F.R.S. Edin. Regius Professor of Natural History in the University of Edinburgh — p. 347

Observations on the rivers, and their agency in forming the soil, of Guiana; their creeks, floods, tides, &c.

VI. On the supposed Revival of Insects after long Immersion in Wine or other intoxicating Liquor. By Mr. John Gough — — p. 353

Experiments on various insects, which prove that the popular notion of their revival many months after their immersion in fermented liquors is ill founded.

VII. Various Notices respecting the Arts in Turkey.—Jeweller's Foil.—Glue, or Mastic for Stones and Metals.—Casting of Malleable Iron.—Filtration by Ascent.—Butter preserved without Salt.—Extemporaneous Yeast p. 355

VIII. Obſervation of the Paſſage of a Comet over the Diſc of the Sun. By Citizen Dangos — — — — p. 357

Time and duration of the phenomenon. Inferences. Why comets cannot be often ſeen on the face of the ſun.

IX. Analyſis of the Aqua-marine or Beryl; and the Diſcovery of a new Earth in that Stone. Read before the French National Inſtitute 26 Pluvioſe, in the Year VI. (Feb. 14, 1798.) By Citizen Vauquelin — p. 358

Method of Analyſis. New earth, ſoluble in acids and in pure potaſh; and affording ſalts of a ſaccharine taſte. Comparative examination of its habitudes, and thoſe of alumine, from which, as well as the other earths, it greatly differs.

X. Deſcription of a new-invented detached Eſcapement for Pocket Watches, &c. By Mr. John Prior — — — p. 363

XI. On Mr. Cartwright's Invention for rendering the Piſtons of Steam Engines, Pumps, and other Hydraulic Apparatus, tight by Metallic Parts, without packing or leathering. (W. N.) — — — p. 364

Letter of enquiry. Deſcription of the invention. Theoretic and practical reaſons why this contrivance muſt prove leſs effectual than the methods already in uſe.

XII. Information reſpecting the Zoonic Acid, diſcovered by Berthollet p. 369

Animal ſubſtances, the vegetable gluten, and yeaſt, afford an acid of deſtructive diſtillation, which may be ſaturated with lime, and the ammoniac then driven off by boiling. By the addition of phoſphoric acid, and diſtillation at the boiling heat, the lime will form a phoſphate, and the new acid will come over. Its characters.

XIII. Hiſtorical Notes concerning the Invention of the Air-pump with Metallic Valves; the Neceſſity of Alkali to produce the cryſtallized Salt called Alum; and the Electrical Inſtrument called the Revolving Doubler — p. 370

XIV. Deſcription of an Apparatus for ſaturating Potaſh and Soda with Carbonic Acid. By Cit. Welther — — — p. 371

XV. Abſtract of a Memoir of Klaproth on a new Metal denominated Tellurium. Read at the Public Seſſion of the Academy of Sciences at Berlin. Jan. 25, 1798 374

Hiſtory of the diſcovery. The white ore of gold is heated with muriatic acid; to which the nitric is afterwards added. The complete ſolution is diluted, and pure potaſh is added in exceſs. A ſmall portion of iron, together with gold, falls down; the reſt is diſſolved by the alkali. Muriatic acid throws down a white precipitate. It is the oxyde of tellurium, and is reducible by being made into a paſte with oil, and ſubjected to a gradual heat. The metal riſes in diſtillation like mercury. It is white, ſhining, brittle, friable, very fuſible, combuſtible with flame, combinable with mercury, and with ſulphur, ſoluble in acids, and in the exceſs of any alkali; not precipitable by pruſſiate of potaſh, &c. &c.

Scientific News, and Accounts of Books — — — p. 376

American Societies. Aeroſtation. Rumford's Eſſays. Rivard on the Sphere and Calendar. Townſon's Mineralogy. Mr. Parke's Travels in Africa.

DECEM-

DECEMBER 1798.

Engravings of the following Objects: 1. A View of the Mansion of Roseapenna, in Ireland, destroyed in Consequence of the Change of Climate supposed to have taken Place in that Island during the present Century. 2. The powerful Electrical Machine of Rouland, which operates by the Friction of Silk.

I. Memoir on the Climate of Ireland. By the Rev. William Hamilton, of Favet, in the County of Donegal; late Fellow of Trinity College, Dublin; M.R.I.A. Corresponding Member of the Royal Society of Edinburgh, &c. — — — — — — p. 381

General opinion that the seasons of Ireland are considerably changed within the memory of man; that the winters are milder, and the summers less warm. Meteorological instruments do not exhibit all the circumstances which influence a climate. Recourse must be had to other observations. The winds of Ireland have, of late years, blown with uncommon violence from the westward. Their effects are particularly marked on the province of Ulster. Interesting facts respecting trees which formerly flourished in Ireland, but cannot now withstand the rigour of the seasons. The sands of the sea have been driven with increased violence on the Irish coast. Instances of the speedy destruction of habitable places and districts from this cause in the Corporation of Bannow, the Mansion of Roseapenna, and other deserted habitations. Increasing violence of the tides from the Atlantic Ocean.

II. Analysis of the Red Lead of Siberia; with Experiments on the New Metal it contains. By Citizen Vauquelin, Inspector of Ores, and Conservator of Chemical Products at the Mineralogical School — p. 387

History of the Siberian Red Lead Ore, and the experiments formerly made upon it. New analysis. 1. By boiling with carbonate of potash, which precipitated carbonate of lead, and formed a neutral salt with the peculiar acid of the ore. Nitric acid deprived this salt of its alkali, which crystallizes by spontaneous evaporation.—Or otherwise, 2. diluted muriatic acid being added to the ore, combined with the lead of the ore, and disengaged the acid. The muriate of lead being insoluble, remained at the bottom, while the peculiar acid of the ore became suspended, together with a small redundant portion of marine acid. This last, after decantation, was abstracted by adding small portions of the oxyde of silver, and left a solution of the acid of chrome. Its nature, properties, and combinations.

III. Information respecting the Earth of the Beryl; in Continuation of the first Memoir on the same Subject. By Citizen Vauquelin — p. 393

Additional Experiments by which the component parts of beryl, and the characteristic properties of the new earth discovered in that stone, are more correctly ascertained.

IV. Observations on Electricity, Light, and Caloric; chiefly directed to the Results of Dr. Pearson's Experiments on Electric Discharges through Water. By a Correspondent — — — p. 396

Remarks on the very loose and inaccurate notions of philosophers concerning electricity, light, and caloric. Animadversions on Dr. Pearson's theory of the decomposition and re-production of water by electricity. On the materiality of heat.

V. An Enquiry concerning the Chemical Properties that have been attributed to Light. By Benjamin Count of Rumford, F.R.S. M.R.I.A. p. 400

Doubt whether light operates chemically in any other way than by generating heat. Experiments on the vitrification of oxyde of gold by the heat of a candle; and by ſolar light. Effect of dilution in rendering the particles more minute and ſuſceptible of elevated temperature. Curious inſtance of gold reduced by charcoal in the humid way with ſolar light—*and without.*

VI. Experiments and Obſervations on the Nature of Sugar, and of Vegetable Mucilage. By Mr. William Cruickſkank, Chemiſt to the Ordnance, &c. p. 406

Chemical examination of ſugar, honey, ſugar of milk, gum arabic, and gum tragacanth. Reſults: That ſugar is compoſed of carbon, hydrogen, and oxygen;—ſugar of milk contains more oxygen and much leſs carbon;—gum contains lime and azote as well as the principles of ſugar;—vegetable farina cannot become ſugar without water and oxygen;—that neither ſugar, if deprived of oxygen, or combined with other matters, nor pure vegetable nor animal mucilage, is capable of fermentation.

VII. On the Art of covering Wire Cloth with a tranſparent Varniſh, as a Subſtitute for Horn; and on other Objects of Public Utility. By Alexis Rochon, of the National Inſtitute of France, &c. — — p. 412

Chineſe manufacture of horn. Wire cloth prepared for lanthorns with glue; and with mica. New covering for houſes. Medical bougies.

VIII. On the Production of Nitric Acid by the Contact of Oxygen very much heated and the Air of the Atmoſphere — — p. 413

New phenomenon of nitric acid from manganeſe. Conjectures reſpecting it.

IX. Analyſis of the Chryſolite of the Jewellers, proving it to be Phoſphate of Lime. By Citizen Vauquelin — — — p. 414

The chryſolite, being pulveriſed and treated with ſulphuric acid, afforded ſulphate of lime, and the phoſphoric acid was diſengaged. In another experiment the lime was taken up by muriatic acid, and precipitated by the oxalic. From both experiments the ſtone was found to contain 54 parts lime, and 46 phoſphoric acid.

X. Account of a ſingular Inſtance of Atmoſpherical Refraction. In a Letter from William Latham, Eſq. F.R.S. and A.S. to the Rev. H. Whitfield, D.D. F.R.S. and A.S. — — — — p. 417

Uncommon view of the coaſt of France from Great Britain at the diſtance of forty or fifty miles. Remarks and references to ſimilar facts.

XI. An Account of Electrical Machines of conſiderable Power, in which Silk is uſed inſtead of Glaſs. (W. N.) — — p. 420

Various non-conductors uſed for the excitation of electricity. Enumeration. Deſcription of the machines of Ingenhouſz, Walckiers, and Rouland, which operate by the friction of ſilk. Their power of excitation.

XII. Experimental Refearches concerning the Principle of the lateral Communication of Motion in Fluids, applied to the Explanation of various Hydraulic Phenomena. By Citizen J. B. Venturi, Profeffor of Experimental Philofophy at Modena, Member of the Italian Society, &c. p. 422

Comparative experiments, fhewing the quantities of water emitted under like circumftances through different tubes. Practical propofition of great utility, by which the expenditure is more than doubled. Roman law concerning the enlargement of pipes for water.

Accounts of Books, &c. — — — — p. 426

Philofophical Tranfactions, Part II. 1798.—Rollo on Diabetes Mellitus.—Pajot-des-Charmes on Bleaching.—Chemical Memoirs of Pelletier.—Leybourn's Tranflation of Dr. Stewart's Propofitiones Geometricæ.—Note refpecting Dalgarme, Leibnitz, Wilkins, and the Univerfal Character.

JANUARY 1799.

Engravings of the following Objects: 1. A New Instrument for ruling parallel Lines for the Use of Engravers: and, 2. Mr. Cavendish's Apparatus for measuring the mutual Gravitation of Bodies, and ascertaining the Density of the Earth.

I. Description of a New Instrument for drawing equidistant and other parallel Lines, with great Accuracy and Expedition, intended principally for the Use of Engravers; with Specimens of its Performance. By W. N. p. 429

The instrument consists of two flat rulers, one of which confines the plate, and the other is made to shift through small intervals by means of a screw and gear, while it constantly preserves its parallelism.

II. Memoir on the Climate of Ireland. By the Rev. William Hamilton, of Favet, in the County of Donegal; late Fellow of Trinity College, Dublin; M.R.I.A. Corresponding Member of the Royal Society of Edinburgh, &c. (Concluded from page 386, Vol. II.) — — p. 431

General effects of the western tempests on the climate of Ireland. The summers are rendered colder, and the winters milder.—This equable temperature is favourable to animal and vegetable life.—Cause of the increased violence of the westerly winds, deduced from the forests of Ireland in particular, and of Europe in general, having been cleared in modern times, and the land cultivated.

III. Experiments and Observations on Electricity—Excitation—The two States—Points of Difference between the Action of weak and strong Electricities compared together. (W. N.) — — p. 438

Cascade of electric fire produced by cutting a hole in the silk flap of the rubber. Beautiful star formed by the plus electricity upon paper. Experiments to determine whether the glass tube in Bennet's electrometer has any effect on the divergence of the gold leaf. Other enquiries respecting the metallic coatings and size of the head of that instrument.—Whether the electricity of conductors is disturbed according to the same law, by the influence of an electrified body, when the power is weak, as when it is strong. Remarkable difference in the operation of pointed bodies and flame in weak and strong electricities.—Whether the laws of attraction and repulsion be the same in strong electricity as in weak.

IV. Analysis of the Red Lead of Siberia; with Experiments on the new Metal it contains. By Citizen Vauquelin, Inspector of Mines, and Conservator of Chemical Products at the Mineralogical School. (Concluded from page 393, Vol. II.) — — — — p. 441

Combinations of the acid of red lead with the alkalis.—Its reduction to the metallic state.—Properties of the new metal.—Denomination and uses in chemistry and the arts.

V. Experiments to determine the Density of the Earth. By Henry Cavendish, Esq. F.R.S. and A.S. — — — p. 446

A wooden arm six feet long was suspended in a horizontal position by a slender wire forty inches long, and to each extremity was hung a leaden ball about two inches in diameter. To these balls

balls, on oppoſite ſides, were preſented two larger balls, which, by their attraction, drew the arm aſide. The arm, with its balls, was incloſed in a wooden caſe, and the whole apparatus placed in a room adapted to this purpoſe, and kept ſhut while the obſerver attended to the effect from without, by means of a ſhort teleſcope oppoſite each end of the bar. The power required to draw the arm aſide, was aſcertained from the time of its free vibrations, and the denſity of the earth computed from the compariſon between the effect of its attraction on the balls with the effect of the ſame nature by which the arm was drawn from its ſtationary poſition. This laſt effect amounted to about one inch and a half when a thin wire was uſed, and about one third of an inch with a thicker wire: the deviations were, therefore, very perceptible. The mean reſult of the earth's denſity proved to be 5,48 times that of water.

VI. An Inquiry concerning the Chemical Properties that have been attributed to Light. By Benjamin Count of Rumford, F.R.S. M.R.I.A. (Concluded from p. 405.) — — — p. 453

Reduction of ſilver by means of charcoal in the humid way under the action of ſolar light, and likewiſe by the heat of boiling water without light. Reductions of gold by ether and ſolar light —by etherial oil of turpentine and the heat of ſteam. Oxydes of gold and ſilver reduced by olive-oil in a ſimilar proceſs. Remarkable precipitation of the ſolution of gold upon magneſia by ſolar light.

VII. Some Account of the Perſian Cotton-Tree. By Matthew Guthrie, M.D. F.R.S. &c. &c. — — — p. 457

Account of various ſpecies of cotton, particularly the Perſian cotton; its cultivation and valuable qualities.

VIII. Facts and Obſervations concerning the Meaſure and Expence of firſt Movers, namely, Wind, Water, Steam, and Animal Strength, and on other Objects of general Utility. (W. N.) — — p. 459

Great waſte of labour and expence incurred by manufacturers and others, for want of a knowledge of the relative powers of men, horſes, and other firſt movers.—Obſervation reſpecting the beneficial tendency of improvements in the application of theſe forces. Power of windmills. Horizontal mills. Water-wheels with inclined pallets. Inſtructions for meaſuring the quantity and power of ſtreams of water. Explanation of the manner in which this power operates. Example in detail to aſcertain the force of a ſtream to be applied to an underſhot-wheel to raiſe water, to grind corn, or to perform the work of a certain number of men or horſes. Enquiries reſpecting the medium effect of animal power. Overſhot-wheels. Eaſy method of levelling to determine the fall of a ſtream of water.

IX. Enquiries concerning the Invention and Practice of the Art of Hatmaking. — — — — — p. 467

X. New Obſervations on the Method of producing very loud Fulminations with various Bodies by Means of Phoſphorus. By Citizen Brugnatelli. p. 468

Experiments in which detonations were produced by placing a ſmall portion of phoſphorus upon various ſubſtances containing oxygen, and ſtriking them with a hammer. Theſe were nitrate of ſilver, oxygenated muriate of potaſh, the nitrates of biſmuth and of mercury, common nitre, the ſulphates (which did not ſucceed) and certain metallic oxydes. Experiments in which ſulphur and charcoal were uſed inſtead of phoſphorus. Additions and remarks by Van Mons.

Tunnel beneath the Thames. — — — p. 473

Abridged account of the plan and proceedings relating to the propofed tunnel beneath the Thames, at Gravefend.—Lift of the committee of fubfcribers, with other particulars relating to the fubfcription.

On Mr. Cartwright's Apparatus for rendering the piftons of Steam Engines tight by Metallic Fittings. — — — p. 476

FEBRUARY 1799.

Engravings of the following Objects: 1. A New Air-pump. 2. A remarkable Lunar Halo: and, 3. Figures illuftrating the lateral Motions of Fluids.

I. On the Corundum Stone from Afia. By the Right Hon. Charles Greville, F.R.S. — — — p. 477

Early notices of the corundum ftone. Particular account, and topographical remarks on the place where it is found in India. It is in common ufe in China. Obfervations refpecting its general properties, fpecific gravity, &c.

II. An Account of a fingular Halo of the Moon. In a Letter from William Hall, Efq. of Whitehall, to Sir James Hall, Bart. F.R.S. Edin. p. 485

Lunar Halo, confifting of a circle round the moon of about 12° in diameter, with another paffing through the moon of about 112°, and very much inclined to the horizon.

III. Experimental Refearches concerning the Principle of the lateral Communication of Motion in Fluids, applied to the Explanation of various hydraulic Phenomena. By Citizen J. B. Venturi, Profeffor of Experimental Philofophy at Modena, Member of the Italian Society, of the Inftitute of Bologna, the Agrarian Society of Turin, &c. — — — p. 487

A fudden bend, or right angle, in a pipe, deftroys nearly half the velocity of a fluid moving through it. Enlargements are fcarcely lefs noxious. Explanation of the effects of the water-blowing machine. Curious method of draining land by a fall of water without machines. Caufes and effects of the eddies and whirls in rivers.

IV. Concerning a new Variety of Argillaceous Iron-ore. By Samuel L. Mitchill, M.D. of New York. — — — p. 494

Argillaceous iron-ore figured like bafaltes. Argument deduced in favour of the aqueous origin of bafaltes.

V. Concerning the Invention of the Electrical Doubler. By Mr. John Read. — — — p. 495

Explanatory letter, with remarks on its contents.

VI. Inquiries refpecting the Conftruction of a Water-wheel, and the Manufacture of Bricks. By a Correfpondent. — — — p. 497

VII. On the Combuſtion of Phoſphorus. — — p. 498

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AND
THE ARTS.

APRIL 1798.

ARTICLE I.

A Memoir and new Experiments on the Artificial Cinnabar of Mr. Kirchoff. By the Count APOLLOS DE MOUSSIN POUSCHIN, *Chamberlain to his Majesty the Emperor of all the Russias, Vice-President of the College of Mines, Honorary Member of the Imperial Academy of Sciences, at Petersburg*, &c. &c.*

THE annual consumption of cinnabar by a variety of manufacturers and artists, and the certain sale of this beautiful colour, render it undoubtedly an interesting object of political economy for all states which possess the ores of quicksilver, as well as a branch of speculation for the merchant which has hitherto supported the manufactories of vermilion, and has even fixed the attention of the industrious Hollanders, who not being able to derive advantage from the fabrication of this product at first hand, have established, as it is said, mills for cinnabar, in which this colour gains the brilliancy and smoothness necessary for its employ in the arts. This process, which they mysteriously conceal, has hitherto been attended with profits the more considerable, as it is pretended that great part of the cinnabar which is adulterated by different processes is vended through Europe from these manufactories at first hand†. The methods by which cinnabar has hitherto been

* Translated from the French manuscript, communicated by Charles Hatchett, Esq. who received it from the author, with some specimens of the cinnabar, which he finds to be of the best quality. The memoir was addressed to the Societé des Amis Scrutateurs de la Nature.

† Mr. Tuckert, who several times assisted, or was present during the preparation of artificial cinnabar at the manufactory of Mr. Brand, without the Utrecht gate at Amsterdam, has given an account of the processes in

been obtained are too well known, and it would be superfluous to mention them here. But as the various inconveniences of sublimation, grinding, and the other preparations of this colour, are frequently prejudicial to the health, and sometimes expose the lives of the workmen to inevitable danger; and as the loss of vessels and the expence of fuel are but too frequently felt by those who undertake this fabrication; it is evident that a method of obtaining cinnabar subject to none of these inconveniences, and requiring little of expence excepting the first cost of the mercury, must become truly valuable to this branch of industry. We are indebted to Mr. Kirchoff, a young chemist of the greatest hopes, who is attached to the pharmaceutic department, for the first discovery of a method no less ingenious than obviously of great probable advantage to commerce. His claim in this respect is beyond controversy. For, though cinnabar has been obtained in the humid way by means of volatile liver of sulphur, there never could have been any hope of applying that method to the purposes of trade, on account of the heavy expence of the re-agent. But the intermedium used by Mr. Kirchoff promises, on the contrary, all the advantages which the most scrupulous calculation can require, and, when brought to perfection, will probably cause the method of sublimation to be abandoned by all who may be desirous of engaging in this branch of commerce, without exposing themselves to unnecessary risque.

I shall proceed to lay before this illustrious Society all the details of the process of Mr. Kirchoff, as well as the inconveniences which have hitherto presented themselves. It is with great pleasure that I avail myself of this opportunity of doing justice to the merits of this chemist, which have been hitherto concealed by his excess of modesty; and I have annexed to this memoir my own proper experiments, which have enabled me to remove some of the principal difficulties which Kirchoff met with in his work. I have no

in Crell's Journal, of which an abstract is inserted in the fourth volume of the Annales de Chimie, page 25. It is concisely as follows: (1.) Ethiops mineral is prepared by combining 150 pounds of sulphur with 1080 pounds of pure mercury, by a moderate heat, in a flat-bottomed polished iron vessel. 2. The ethiops, after slight pulverization, is put into earthen bottles, each capable of containing a quart of water. 3. Three large pots or sublimatory vessels, made of very pure clay and sand and luted, are then taken and placed upon iron circles over furnaces, constructed in such a manner that the flame of the fuel, which is turf, circulates freely round the vessels to two-thirds of their height. 4. When the vessels are red-hot, a bottle of the ethiops is poured into the first, another into the second, and another into the third. In the subsequent progress of the operation, two, three, and perhaps more bottles may be poured in at a time; but this depends on the strength of the inflammation exhibited by the ethiops after its introduction, the flame of which sometimes rises to the height of four and even six feet. When this is a little diminished, the mouth of the vessel is covered with a plate of iron, one foot square and an inch and a half thick, which perfectly closes it. In this manner during thirty-four hours the whole of the prepared matter is introduced into the three pots; that is to say, into each pot 360 pounds of mercury and 50 of sulphur. 5. The fire is then kept up till the sublimation is completed, and afterwards suffered to go out; which requires 36 hours from the time of the complete charge. It is judged to have the proper intensity, when, upon taking off the cover, a brisk flame appears, but does not rise more than three or four inches out of the pot. 6. During the last 36 hours, the mass is stirred every quarter or half hour with an iron rod. 7. When all is cold, the vessels are removed by means of the iron circles, which prevent their breaking. The cinnabar is taken out by breaking the vessel. Each pot constantly affords 400 pounds of cinnabar, the loss of original weight in each being 10 pounds. The cinnabar does not attach itself to the plates of iron, because they are continually taken off excepting towards the end, when the vessels are left untouched. These plates are not in the least corroded. N.

other

other claim than that of having endeavoured to render his discovery as useful as possible to technical chemists.

Mr. Kirchoff, who has operated in the small way only, gives the following proportions for the production of cinnabar in the humid way:

Three hundred grains of mercury are triturated in a vessel or cup of porcelain, with 68 grains of flowers of sulphur, until an ethiops is accurately produced, in which no metallic globules can be perceived by the magnifier. As this degree of union of the mercury and sulphur cannot be obtained when both are perfectly dry, Mr. Kirchoff adds a few drops of a solution of caustic vegetable alkali; and when the union of the mercury and sulphur is complete, he adds to the mixture a solution of 160 grains of the same alkali dissolved in an equal quantity of water. He heats the vessel containing these ingredients over the flame of a candle, and triturates without interruption during the heating with a glass pestle. In proportion as the liquid evaporates, he adds clear water from time to time, so that the ethiops may be constantly covered to the depth of near an inch. For the above quantities, it is requisite to continue the trituration nearly two hours; at the end of which time the mixture begins to change from its original black colour to a brown, which usually happens when a large part of the fluid is evaporated. From this first moment the transition from brown to red is very rapid. No more water is then to be added, but the trituration must be continued without intermission. When the mass has acquired the consistence of a jelly, the red colour becomes more and more bright with an incredible degree of quickness. This is the most important point of time for the success of the operation. For, if the heat be not continued long enough, the colour will not acquire the utmost degree of beauty; and on the contrary, if it be continued only two seconds too long, the fine red of the cinnabar passes as quick as lightning to a dirty brown. Mr. Kirchoff, as well as Mr. Lowitz, who has repeated his experiments, could not succeed in amending this brown colour; which consequently renders the success of the operation very precarious. This inconvenience is productive of another; namely, that it is nearly impossible, at the instant of the production of the colour of the cinnabar, to make any observation of the quality of the tint. For the colour of the liver of sulphur masks that of the cinnabar; so that in some instances the most beautiful red is obtained, and in others a colour inclining to orange, which, though bright and vivid, is not the tinge required in this product. In one of his experiments, Mr. Kirchoff obtained a cinnabar which absolutely possessed the colour of carmine; but he had this good fortune only once, when he had no expectation of so beautiful a product, and did not therefore note the attendant circumstances.

This is nearly the whole detail of the experiments hitherto made by Messrs. Kirchoff and Lowitz. The cinnabar they obtained still exhibited mercury in the metallic state, which it was rather difficult to get rid of, and did not appear until after the filtration of the liver of sulphur, and the edulcoration and drying of the vermilion.

I shall now proceed to relate what I have done respecting this object, principally with a view to facilitate the manufacturing in the large way, the restoration of the cinnabar which had assumed a brown colour instead of red, and the certainty of the tint in masses somewhat considerable. I am very far from being content with the success of my experiments; but I think I have at least discovered great part of the theory of the operation, and that in

practice the manufacturer will soon discover the necessary proportions and manipulations. I therefore claim and hope for the grant of indulgence in favour of the desire I have, that the valuable discovery of Kirchoff may speedily become as useful to society as undoubtedly it will sooner or later be.

The first experiment I made in small, according to the exact proportions of Kirchoff, did not succeed. I could not transform my ethiops into cinnabar. I attribute this want of success to an evaporation too rapid, and the want of a sufficient quantity of fluid; not having added water in proportion as the mixture became thick, so that the whole soon became perfectly dry. The mass became strongly attached to the china cup, and constantly preserved its black colour. I recommenced the operation with more success, and all my experiments afforded cinnabar more or less beautiful, provided the mixture at the commencement was kept at the proper degree of fluidity. Most frequently however I obtained a colour, which, though very brilliant, inclined rather to yellow than red; a fault which the cinnabar of sublimation possesses but too frequently, and is sometimes a proof of its falsification. Among the colours which I obtained, brown presented itself but too frequently, in consequence of having neglected the moment of terminating the operation. I made the following experiments on these defective colours:

After well edulcorating a cinnabar of this kind, I poured on three different portions: the nitrous, the acetous, and the muriatic acids. These were exposed for several hours to a mild digesting heat. I had supposed that the defect of the colour might arise either from a partial reduction of the mercury, or partial fusion of the sulphur, or perhaps from an adulteration of the mercury by lead. In these three experiments, therefore, my aim was to dissolve the reduced mercury, to oxide the sulphur, or to carry off the lead by the acetic acid. None of these experiments answered my expectation; for, though part of the mercury was dissolved and part of the sulphur oxided, the colour continued brown. That with the nitrous acid was even darker. The acetic acid afforded no indications of lead.

As the result of these experiments showed that the bad colour of the cinnabar did not arise from a portion of reduced mercury, I wished to know whether the metal were not combined with too large a portion of sulphur; for which purpose, I digested caustic alkali on the cinnabar. The alkaline solution became yellowish, and the colour of the cinnabar somewhat lighter, but was not a good red. It always inclined to yellow; and though it approached very near the colour of common cinnabar, and was even more vivid, yet it was not red enough.

I had little expectation of restoring the proper colour and vividness to my damaged cinnabar. Nothing more remained but to try the addition of mercury to the brown colour which was the object of my research. I therefore moistened near an ounce and a half of this colour with water, then gradually added near three ounces of running mercury, and triturated the whole on a very hard Siberian porphyry. Contrary to my expectation, the mass, instead of becoming black, assumed the colour of an extremely pale cinnabar, without the smallest degree of fire or liveliness. I then mixed two drams of the flowers of sulphur, and collected the whole in a porcelaine cup. Upon this I poured a solution of the caustic alkali, evaporated as before to a very thick consistence. The mixture passed from yellow to an obscure brown, and at the moment of the thickening a large quantity of running mercury was seen at the bottom of the cup. I added a dram and a half of sulphur,

sulphur, with a few drops of water, and triturated the whole until the mercury had entirely combined with the rest of the mixture. I then added water, and began the evaporation, agitating the mixture continually with the pestle. The brown colour began towards the end of the evaporation to brighten, and at last changed to the colour of bad sealing-wax, constantly inclining to brown. Foreseeing that if I continued the evaporation I should risk a second obscuration of the colour, I placed the cup which contained the mixture on a stove which had been heated. At that time I totally despaired of correcting the colour of cinnabar spoiled at the first evaporation; but having inspected my cinnabar at the end of two hours, I saw with pleasure that the colour had become finer as the mass became thicker. I triturated it in the cup with the addition of a few drops of water, and repeated this operation five or six times in the course of the day. At the end of 24 hours, my cinnabar was very thick and very good. I added more water, and left the colour on the stove for three days; at the end of which the cinnabar had acquired the utmost brilliancy, and was equal to the finest specimens of Mr. Kirchoff, excepting that in which he had obtained a shade of carmine, as I have already remarked. After repeating this experiment with success with one pound of mercury, thirty-five drams of flowers of sulphur, and ten ounces of caustic alkali, I found reason to make the following general observations upon this process:

It is necessary for the production of cinnabar,

1. That the mercury should be perfectly mixed with the flowers of sulphur; for which reason, after having triturated it with the pestle in a glass mortar, with the addition of a small quantity of caustic alkali to moisten it, it must be levigated upon porphyry, or such other hard stone as cannot mix its particles with those of the cinnabar, because every foreign substance is highly prejudicial to the beauty of the colour. If the quantities operated upon exceed one pound, it will be necessary to procure a mill for grinding colours, which must also be of a siliceous stone. The mixture upon a levigating stone is evidently too expensive for a manufacturing process in the large way.

2. The best vessels for evaporating the mixture are those of porcelaine, or the yellow ware of England. The pestles ought to be glass.

3. The heat of a sand-bath is sufficient to this operation. The heat of ebullition is not necessary; but at the beginning, particularly when there is much liquid, the heat must approach as nearly as possible to that of boiling.

4. The receptacle in which the sand is placed must be deep enough to admit the whole of the porcelaine or earthen vessel in which the cinnabar is produced, to be plunged therein, and environed by an equal atmosphere of heat. The sand round the vessel need not exceed the thickness of a full inch.

5. The mixture must be perpetually stirred: otherwise the mass will subside by its weight, and become clotted; a circumstance which it is essential to avoid.

6. A certain degree of thickness is requisite during the operation, in order to afford a good colour; but great care must be taken not to suffer the mass to become too thick, and more particularly the agitation must be strongly kept up at these periods of condensation.

7. Though it is possible to obtain from the sand-bath a very beautiful cinnabar which may be immediately edulcorated, yet it is much more prudent and advantageous not to suffer

ſuffer the product to acquire its whole perfection on the evaporating furnace, but to take it in time from the ſand-bath, and leave it for three or four days in a degree of heat equal to that of the ſtove of an apartment after it has been heated for two or three hours. Care muſt be taken to add a few drops of water, and to agitate the mixture from time to time. By this precaution, the diſagreeable event of ſeeing the colour paſs from red to yellow, and often to brown, is avoided, as well as the ſubſequent labour and expence of trituration with mercury, and additional liver of ſulphur.

8. Before the cinnabar is edulcorated, it may be left to become almoſt perfectly dry by the heat of the ſtove; by which means the colour will acquire the moſt brilliant tint.

After this account of the production of cinnabar in the humid way, I ſhall ſpeak of the edulcoration and drying of this colour, which have preſented phenomena of the greateſt importance to the fabrication in the large way, and are alone ſufficient to ſecure real advantages to the ſpeculator in this article.

Having obtained ten ounces of cinnabar, I poured twenty pounds of boiling water upon it in a large earthen jar, for the purpoſe of diſengaging the liver of ſulphur. At that moment the liquid was obſcured and became abſolutely black. I ſlightly agitated the mixture. The cinnabar very ſpeedily fell to the bottom, and permitted me to decant this black liquor, of which I ſhall hereafter ſpeak. After having poured other water upon the cinnabar, which was conſiderably beautiful, it acquired a ſlight yellow colour. After the ſettling of the colour, I decanted it, and continued to edulcorate until the decanted water had neither the ſaline ſulphureous taſte, nor hepatic ſmell.

When I had poured for the laſt time five or ſix pounds of boiling water on my colour, I agitated it ſtrongly, and poured it out into a veſſel of cryſtal glaſs. A plentiful depoſition of colour was made in an inſtant. It was not bad, but did not poſſeſs the brilliancy of the particles which floated in the water above this depoſition. I agitated the water very ſlightly, that it might become more highly charged with colouring matter, but not ſo much as entirely to derange the maſs which had ſubſided. I rapidly decanted the liquid part into another veſſel. The moſt denſe portion remained at the bottom, and on the ſides of the firſt glaſs, and was of a very beautiful colour. I repeated this waſhing four times with the ſame precautions, taking care always to pour the liquid part haſtily into another veſſel. The reſidue of the laſt waſhing was entirely brown, and the tints of my cinnabar were beautiful in the ſame order as I had obſerved in the decantation. That is to ſay, the colour in the firſt veſſel was more brilliant and leſs deep than in the ſecond, and ſo of the others. This experiment ſhowed not only that waſhing adds to the beauty of the cinnabar obtained by the proceſs of Kirchoff, but that it is poſſible, more eſpecially in works on a large ſcale, to obtain a great variety of tints by mixture, without admitting any foreign colour or material.

After having thus obtained different cinnabars by waſhing, I dried them on a furnace ſlightly heated, and found them more or leſs deep, but generally very good. They did not, however, poſſeſs the fire of ſuch cinnabars as inclined to a yellow colour. I put theſe colours into capſules of paper, and left them for ſome days on the ſame ſtove, which had continued to be regularly heated. At the end of this time, upon opening my papers it appeared to me that the colour was improved, and had in particular become more lively than

than on the first day. In order to ascertain whether this phenomenon was owing to simple drying, or to heat, I placed a pinch of the lightest colour on a small piece of glass, which I heated very strongly with a candle. I then enjoyed a very beautiful sight, of which the result gave me the greatest pleasure. The powder of cinnabar became brown in an instant, and soon afterwards nearly black, or rather of the deepest violet grey; but when, on the supposition that I had spoiled my cinnabar, I threw it from the glass upon a paper, I was very agreeably surprised to observe it in the twinkling of an eye pass through all the transitions from obscure violet to a beautiful carmine red, and to observe more particularly that this colour had acquired the fire and brilliancy which was wanting before the experiment. As an object of comparison, I had some cinnabar of commerce, of which the pond, or forty pounds (Russian), is sold at Petersburgh for eighty roubles. I put a pinch of this on the same slip of glass, and subjected it to the same treatment. The colour speedily became black, and, after cooling, acquired a very bad deep brown tinge, resembling umber of a bad quality, without recovering its original red. I repeated this experiment in a larger way with the same success, and by that means ascertained a method of giving in general much brilliancy to my cinnabar, and of producing the most brilliant carmine tint. This heat, which must be very strong, requires, nevertheless, to be conducted with much prudence. The cinnabar must not fume, nor exhibit grey globules on its surface; for in these cases it would be effectually spoiled. This phenomenon seems to prove a decomposition and absorption of air; but it remains to be shown whether it be hydrogene, oxygene, or azote, which the cinnabar takes up in this experiment.

These constitute the most essential facts I have observed with regard to the production of cinnabar in the humid way. I intend, when time permits, to give a continuation of this memoir. I have already made some new experiments, which, though they may not yet promise any advantage to the manufacturer in the large way, may be useful to the painter and interesting to the chemist.

The black liquor which I at first decanted from my cinnabar, deposited a small portion of ethiops, not surcomposed. I must add in conclusion, that the manufacturer in the large way must of course submit his colour to several elutriations, collect the depositions in several vessels, and afterwards mix his colours when dried. It would be likewise necessary for the finer sorts, to provide a furnace, in which either the carmine colour or the requisite fire and brilliancy may be given. A furnace of this kind may very easily be contrived, and it would be unnecessary to describe its construction in this place. It is my wish, that the society to whom I have the honour to address the present memoir will consider it as a proof of my respect and gratitude. By admitting me into the number of its members, a new proof is afforded of its indulgence to the weakest efforts in favour of the sciences and natural history. The excellent discovery of Mr. Kirchoff has led me to ascertain some new facts, of which I am desirous that commerce should have the advantage; but the honour of the discovery belongs to him, and deserves to be the more insisted on, as his modesty is no less conspicuous than his knowledge.

II.

On the Luminous Appearance faid to be exhibited by Phofphorus in Azotic Gas.

By Dr. Alexander Nicholas Scherer, *Counfellor of the Mines to his Serene Highnefs the Duke of Saxen Weimar**.

AT the time when the principles of the new theory were newly difcuffed, the enquiries of chemifts were employed upon fome of its chief affertions. Befides examining the experiments that metallic oxyds do emit oxygen gas during their reduction, attention was alfo paid to another, by which it was obferved, that the combuftion of bodies in oxygen gas is always accompanied by a total abforption.

Mr. Goettling, who exerted his induftry on fuch experiments, made ufe of the apparatus he employed in feveral experiments of the fame nature. He accidentally obferved, that the phofphorus continues to fhine for fome time in the azotic gas, which remains after its combuftion in atmofpheric air. What he principally obferves on this head is, that phofphorus fhines very ftrongly in azotic gas, even more fo than in atmofpherical air; that it is converted into phofphoric acid by this procefs; and that the azotic gas totally difappears. Hence he was led to infer, that azotic gas muft contain oxygen, as well as the oxygen gas itfelf does.—But if fo, what is the difference between thefe two fpecies of gas? This queftion was apparently folved by another experiment he made. Phofphorus does not fhine fo well in oxygen gas at a low temperature, as it does in the azotic; and when phofphorus gives light in atmofpherical air, it is always with extrication of heat; whereas the light is not attended with heat in azotic gas. He concludes therefore, that the azotic gas confifts of oxygen combined with light, in the fame manner as, on the other hand, the oxygen gas confifts of that principle combined with caloric; and moreover that caloric has a ftronger affinity to oxygen than light has.—On this Mr. Goettling builds an entirely new theory of chemiftry, from the confideration that the new mixture of azotic gas, which he pretends to have difcovered, does not admit of the hitherto adopted way of explaining its influence.

Mr. Goettling has explained thefe facts at large in his *Beytrag zur Berichtigung der antiphlogiftifchen Chemie.* Weimar 1794. This work was univerfally well received, and fome were inclined to give it full credit without further examination. Mr. Goettling himfelf has publicly explained his new theory, and adapted the whole of his chemical lectures to that fyftem. A few philofophers only ventured to offer their doubts concerning it. Among thefe are Dr. Eimbke; *Intelligenzblat der allg. litt. Zeit.* 1794, No. 92, and Yelin; *Erlang. gel. Zeit.* 1794, No. 80. The former obferved, that when phofphorus had ceafed to fhine in atmofpheric air, it would afford no more light in the remaining azotic gas. The fecond found, that phofphorus, after undergoing a very long continued heat in atmofpherical air, does alfo leave behind an aëriform refidue, in which the phofphorus will by no means fhine any longer.

At this time I had commenced a public courfe of lectures on Chemiftry. I therefore thought myfelf obliged to make new enquiries for the purpofe of giving an impartial ac-

* Received from the Author.

count

count of this new discovery; but to avoid being led into error by individual observations, as is frequently the case with experiments, I joined Dr. Jaeger from Stuttgard, who was just then visiting me on a journey. We made a great number of experiments together, which we endeavoured to diversify in every possible manner, in order to discover all the concurrent circumstances. In the *Jena. gel. Zeit.* 1794, No. 113, we published a short account of one of the chief occurrences; but the full description of the results from our investigations some time after was given in the following book, *Uber das Leuchten des Phosphors im atmospherischen Stickgas.* Weimar 1795. To this work we have added another treatise on Goettling's theory by Dr. Pfaff.

The chief aim of this enquiry was to shew by decisive experiments, *whether phosphorus does really give light in azotic gas, and whether it be totally decomposed by it?* Neither of these two we could find by any process of operation. We made comparative experiments over water and over quicksilver, and clearly perceived that Mr. Goettling, having closed his vessels merely by water, could not avoid a source of error. We spared no exertions to investigate as exactly as possible the method of preparing azotic gas, and by that means discovered a variety of interesting circumstances. We always found that the fumes of *phosphoreous acid*, rising by a momentary combustion of phosphorus in atmospherical air, did so far envelope the remaining portion of oxygen, that the luminous appearance from the union of this with another part of the phosphorus could not be again produced until the water had absorbed the acid fumes. We always found however that this light was of short duration, accompanied by a very inconsiderable diminution of the elastic fluid, and that it was altogether impossible to cause the phosphorus to emit any more light in the remaining air. On this account we had every reason to consider this as pure azotic gas, and to declare those experiments of Mr. Goettling incorrect, from which the combustion of phosphorus was said to take place in the *purest azotic gas.*

To all this Mr. Goettling made no reply, except that he gave an answer in the *Intelligenzbl. der allgem. Literat. Zeit.* 1794, No. 117, to our first very short notice, tending to place the whole investigation in an unfavourable point of view. Of our treatise, though printed above two years ago, he has not yet taken any notice.

Soon afterwards Mr. Girtanner took some pains to explain the result of Mr. Goettling's experiments, *Ibid.* 1795, No. 23, by supposing the azotic gas employed had contained some water, which was decomposed by the phosphorus. He did not, however, take the trouble to ascertain by experiments, whether phosphorus does really give light in azotic gas thoroughly freed from oxygen. Mr. Goettling replied to this, by alledging, that if the water which exists dissolved in the gases were the cause of this light, the phosphorus ought also to emit light in oxygen gas, which according to his experiments did not take place. *Ibid.* No. 27. He afterwards published a more ample elucidation of the short answer here related in the *Almanach fuer Scheide Kuenstler*, 1795, asserting that the luminous appearance of phosphorus could not be obtained in an azotic gas, which had been procured by a long continued heating of the phosphorus in atmospheric air, because in that case the phosphorus mixes with the azotic gas, and prevents it from maintaining the light. He added, that the gas thus circumstanced is found to recover this property by adding a few drops of an acid. But he was by no means aware that his observation contained a very important objection against his own theory. For if, according to that theory, azotic gas

gas be really a compound of oxygen and light, why ſhould the phoſphorus, on being mixed with it, ceaſe to act on its oxygen? Ought it not rather to do this more ſpeedily when the coheſion of its parts is deſtroyed? Beſides which, the addition of acids is not fair, becauſe more acid than is neceſſary to ſaturate the phoſphorus diſſolved in it, may in this way become united with the azotic gas. Thus I have found that the phoſphorus, which does not ſhine in pure carbonic acid gas, begins to give light in that medium as ſoon as a ſmall portion of acid is added. The anſwer given by Dr. Jaeger was more explicit. He diſcovered in particular, that the volume of the azotic gas was never diminiſhed when the luminous appearance of the phoſphorus was reproduced by means of acids. *Gren's Neues Journal der Phyſik.* B. II.

It was not long after, that Profeſſor Lampadius publiſhed his experiments on this ſubject. At firſt he ſeemed to find every thing exactly as deſcribed by Mr. Goettling, *Ibid.* B. I.; but ſoon afterwards he made the intereſting diſcovery, that by a careful decompoſition of atmoſpherical air, by means of nitrous gas, azotic gas may be procured, ſo free from oxygen, that phoſphorus cannot be made to ſhine in it. *Sammlung pract. chemiſch. Abhandl.* B. I.

Profeſſor Hildebrandt repeated Mr. Goettling's experiments with the greateſt care. *Crell's Annal.* 1796, B. I. Theſe experiments are, no doubt, the moſt exact of any that were made for this purpoſe. He has perfectly confirmed our experiments. He has proved this beyond all queſtion, by ſeveral experiments, of which I ſhall mention but one.—In the ſame azotic gas in which phoſphorus had ceaſed to ſhine, and freſh phoſphorus would not afford light, the luminous appearance took place as ſoon as oxygen gas was added. But this laſted no longer than till the latter was conſumed; for there was preciſely as much of the whole volume of the mixture abſorbed, as made up the quantity of the oxygen gas that was added.

There are ſeveral well known papers on this ſubject, in the *Annales de Chimie*, written by French chemiſts; but none of their authors have paid the leaſt attention to what has been tranſacted on this matter: a circumſtance which I have thought proper to be mentioned in this place. But they have added the important fact, that phoſphorus is ſoluble in azotic gas. Probably they had no intelligence of what has been written about it in Germany; and as this appears to me to be the caſe with England, I conſidered it of ſome importance, to give the ſhorteſt poſſible view of the chief points of theſe tranſactions. I have endeavoured to give a more ample detail of all the particular facts, as far as they were known down to October 1796, in a work of mine, equally unknown in this country: *Nachtraege zu den Grunzuegen der neuern chemiſchen Theorie*, pag. 326—349, in which the whole extent of theſe enquiries may be ſeen with greater eaſe by the ſyſtematical arrangement of the experiments. It is to be hoped that the diſpute will end here, and that the facts, (1.) that no ſhining of the phoſphorus can in any reſpect take place in ſuch azotic gas as is quite free of oxygen, and (2.) that it cannot be made to ſhine unleſs ſome other body be added which is capable of affording oxygen,—will be admitted as incontrovertibly eſtabliſhed.

LONDON, *Feb.* 27, 1798.

III. *On*

III.

On M. Lazowski's new Barometer, or Weather Inſtrument. By a Correſpondent.

To Mr. Nicholson, Editor of the Philoſophical Journal.

Sir, *Kendal, Jan. 31, 1798.*

THE following experimental eſſay is too trifling to require an introductory apology, were it not for the high name of Dr. Hutton, which unavoidably occurs in the courſe of it, as the ſubject of the preſent communication was firſt ſuggeſted by a paragraph in his Mathematical and Philoſophical Dictionary, publiſhed in 1795.

When any thing new in ſcience is announced, it ought to be made public as generally and as ſpeedily as poſſible. In this reſpect Dr. Hutton has only done his duty as a compiler, in bringing the Engliſh reader acquainted with the ſuppoſed diſcovery of a new inſtrument capable of indicating approaching changes of the weather. On the other hand, when any thing novel is communicated to the lovers of ſcience, it is the buſineſs and undoubted right of every friend to enquiry, not to receive the propoſal on bare authority, but to ſubject it to the teſt of argument and experiment, in order to eſtabliſh it as a fact, or refute it as an error.

Having premiſed thus much in my own vindication, I will in the next place tranſcribe the paragraph alluded to above. "To the foregoing may be added a new ſort of Barometer, or Weather Inſtrument, by the ſound of a wire. This is mentioned by M. Lazowſki, in his Tour through Switzerland: it is as yet but in an imperfect ſtate, and was lately diſcovered there by accident. It ſeems that a clergyman, though near-ſighted, often amuſed himſelf with firing at a mark, and contrived to ſtretch a wire ſo as to draw the mark to him to ſee how he had aimed. He obſerved that the wire ſometimes ſounded as if it vibrated like a muſical cord; and that after ſuch ſoundings, a change always enſued in the ſtate of the atmoſphere, from whence he came to predict rain, or fine weather, &c.*"

After peruſing this ſingular narrative, I found myſelf at a loſs in attempting to refer the diſcovery to any known claſs of phenomena, or to explain it by the affections of the atmoſphere, conſidered as depending on the barometer, electricity, or even the hygrometer, without admitting a ſuppoſition, which is not diſcountenanced by the preceding report, viz. that one end of the wire was fixed to a frame of wood, while the other end was ſtretched over a nail or metal pin in the ſame by a weight. Under theſe circumſtances, it appeared not impoſſible, that the wood-work might contract and expand from ſucceſſive variations in the air's humidity, thereby putting the pin in motion, which may be ſuppoſed to ſcratch the wire, and give riſe to the ſound in queſtion. But with a view to aſcertain if a vibratory motion can be excited in metallic ſtrings by any other change in the ſtate of the atmoſphere, I fixed a number of copper and iron wires, in the beginning of April 1795, in an open place: they were different lengths, from three to ſix feet, and of different diameters, varying from the thickneſs of a fine thread to the ſize of a ſmall cord; they were all ſtretched by metal pins, reſembling thoſe uſed in a harpſichord, and ſo diſpoſed as to make various angles with the meridian and the horizon. The apparatus, being thus completed,

* See Hutton's Dictionary, article *Barometer.*

was carefully attended to through the ſummer, particularly when the aſpect of the ſky and ſtate of the barometer ſeemed to predict an approaching change; but the enquiry was fruitleſs, the promiſed ſound was never heard; nor did any other circumſtance worthy notice occur, except that ſome of the ſmalleſt wires ſnapped occaſionally in the cold nights of the ſpring. The failure of this experiment ſeems to confirm the ſuppoſition that M. Lazowſki's inſtrument is at beſt but an imperfect Hygrometer, and that it does not promiſe any new diſcovery relative to the properties or compoſition of the atmoſphere *. J. G.

IV.

Obſervations on Scylla and Charybdis †. By the Abbé LAZZARO SPALLANZANI, *Profeſſor of Natural Hiſtory at Pavia, F.R.S. &c. &c.*

SCYLLA and Charybdis, according to the fables of the poets, are two ſea monſters whoſe dreadful jaws are continually diſtended to ſwallow unhappy mariners; the one ſituated on the right, and the other on the left extremity of the Strait of Meſſina, where Sicily fronts Italy.

> Dextrum Scylla latus, lævum implacata Charybdis
> Obſidet: atque imo barathri ter gurgite vaſtos

* The paſſage in Dr. Hutton's Dictionary will admit of the ſenſe, that the obſerver (who perhaps never took notice of his wire, except when buſied in the amuſement there mentioned) did not hear any ſpontaneous ſound, but merely perceived a muſical vibration at certain times during the act of drawing the mark along the wire, which muſt have agitated it. This might ariſe from tenſion, by ſome hygrometric change in the ſituation of the points of ſupport. It may be remarked, that a wire for the uſe the clergyman applied it to muſt have been much longer than ſix feet; and that it was probably leſs ſtretched than the wires expoſed by my correſpondent.

If the ſounds were ſpontaneous, the fact will be referable to the Eolian harp of Merſennus, ſince re-invented by Oſwald. The inſtrument conſiſts of a ſounding board about two feet or more in length, upon which ten or twelve (catgut) ſtrings of equal length but different thickneſs are tuned in uniſon, at as low a pitch as the ſmalleſt of the ſtrings can bear. When this is placed in a current of air, ſuch for example as paſſes through a window partly opened, it emits a variety of contemporaneous and ſucceſſive tones, which from their changes in melody, harmony, and ſwell, and a certain wild ſtrangeneſs in the whole effect, rivet the attention, and ſometimes afford exquiſite pleaſure. The Eolian harp has been celebrated by Thomſon and other poets. I have not made experiments to analyſe its mode of operation; but am diſpoſed to think, (1) that it can only give the trumpet notes; (2) that the note to be afforded by any one ſtring depends on the quantity of the impulſe of the wind being greateſt near one end of that ſtring; (3) that the ſame quantity and direction of impulſe will agitate a longer portion of the ſlack ſmall ſtring than of the tenſer thick ſtring, ſo that in the vibratory ſubdiviſions the ſmaller ſtring will give the graver tone; (4) that a powerful tone drawn from one ſtring may diſpoſe the other ſtrings to vibrate uniſons, fifths, thirds, octaves, and other concords, more or leſs remote according to the circumſtances.

If M. Lazowſki's wire acted upon the principle of the Eolian harp, it might be preſumed that the recurrence as well as the nature of the ſound emitted would be governed by the force and angle of direction of the wind; and, if ſo, much would depend on the expoſure the direction and the tenſion of the wire. Whether on this ſuppoſition it could afford any more certain indication of approaching change of weather, than is uſually obtained from a ſimple obſervation by the wind vane, muſt be decided by facts, if ſuch ſhould hereafter appear. N.

† Travels in the Two Sicilies. Engliſh Tranſl. IV. 168.

Sorbet

Sorbet in abruptum fluctus, rurfufque fub auras
Erigit alternos, et fidera verberat undâ.
At Scyllam cæcis cohibet fpelunca latebris,
Ora exertantem, et naves in faxa trahentem.
Prima hominis facies, et pulchro pectore virgo
Pube tenus: poftrema immani corpore priftis,
Delphinûm caudas utero commiffa luporum.

VIRG. Æneid. Lib. III.

Far on the right her dogs foul Scylla hides:
Charybdis roaring on the left prefides,
And in her greedy whirlpool fucks the tides,
Then fpouts them from below: with fury driv'n
The waves mount up, and wafh the face of heav'n.
But Scylla from her den with open jaws
The finking veffel in her eddy draws,
Then dafhes on the rocks. A human face
And virgin bofom hide her tail's difgrace;
Her parts obfcene below the waves defcend
With dogs enclos'd, and in a dolphin end.

DRYDEN.

I have no difficulty in availing myfelf of the defcription of a poet in a work dedicated to the inveftigation of truth, nor fhall I hefitate to cite fimilar paffages from another poet; fince, however exaggerated thefe may be by the glowing colours of imagination, they contain truth, and afford a fubject for interefting enquiries.

I fhould have thought myfelf to have merited the greateft cenfure, if, when I was in the ftrait of Meffina, I had not vifited two places of which fo much has been written, and which have been rendered fo famous by the numerous fhipwrecks they have occafioned.

I firft proceeded in a fmall boat to Scylla. This is a lofty rock, diftant twelve miles from Meffina, which rifes almoft perpendicularly from the fea on the fhore of Calabria, and beyond which is the fmall city of the fame name. Though there was fcarcely any wind, I began to hear, two miles before I came to the rock, a murmur and noife like a confufed barking of dogs, and, on a nearer approach, readily difcovered the caufe. This rock, in its lower parts, contains a number of caverns, one of the largeft of which is called by the people there *Dragara.* The waves, when in the leaft agitated, rufhing into thefe caverns, break, dafh, throw up frothy bubbles, and thus occafion thefe various and multiplied founds. I then perceived with how much truth and refemblance of nature Homer and Virgil, in their perfonifications of Scylla, had pourtrayed this fcene, by defcribing the monfter they drew as lurking in the darknefs of a vaft cavern, furrounded by ravenous barking maftiffs, together with wolves to increafe the horror:

Ενθα δ' ενι Σκυλλη ναιει δεινον λελακυια·
Της ητοι φωνη μεν ὁση σκυλακος νεογιλης
Γινεται. HOM. Odyff. XII.

Here

Here Scylla bellows from her dire abodes,
Tremendous peſt! abhorr'd by man and gods!
Hideous her voice, and with leſs terrors roar
The whelps of lions in the midnight hour! Pope.

The Greek poet, when he pourtrays the rock which is the habitation of Scylla, finiſhes the picture higher than the Latin, by repreſenting it as ſo lofty that its ſummit is continually wrapped in the clouds, and ſo ſteep, ſmooth and ſlippery, that no mortal could aſcend it, though he had twenty hands and twenty feet.

Οι δε δυω σκοπελοι, ὁ μεν ουρανον ευρυν ικανει
Οξειῃ κορυφῃ, νεφελη δε μιν αμφιβεβηκε
Κυανεη, το μεν ουποτ' ερωει, ουδεποτ' αιθρη
Κεινου εχει κορυφην, ουτ' εν θερει ουτ' εν οπωρῃ.
Ουδε κεν αμβαιη βροτος ανηρ, ου καταβαιη,
Ουδ' ει οἱ χειρες γε εεικοσι και ποδες κεν.
Πετρη γαρ λις εστι περιξεστη εικυια. Hom. Odyſſ. XII.

High in the air the rock its ſummit ſhrouds
In brooding tempeſts and in rolling clouds;
Loud ſtorms around and miſts eternal riſe,
Beat its bleak brow and intercept the ſkies.
When all the broad expanſion, bright with day,
Glows with th' autumnal or the ſummer ray;
The ſummer and the autumn glow in vain,
The ſky for ever low'rs, for ever clouds remain.
Impervious to the ſtep of man it ſtands,
Though borne by twenty feet, though arm'd with twenty hands.
Smooth as the poliſh of the mirror riſe
The ſlippery ſides, and ſhoot into the ſkies. Pope.

Such, three thouſand years ago, or nearly ſo, appeared the rock of Scylla, according to the obſervation of Homer; and ſuch is nearly its appearance at this day.

The accuracy of this truly "firſt great painter of antiquity," which has likewiſe been obſerved by ſcientific travellers in other deſcriptions which he has given, ſhews that the level of the waters of the ſea was at that time at nearly the ſame height as at preſent, ſince, had it ſunk only a few fathom, it muſt have left the foot of the rock, which, according to my obſervations, is not very deep, entirely dry. And this I conſider as one among ſeveral ſtrong arguments, that the moſt remarkable ſinkings of the ſea are anterior to the time of Homer.

Such is the ſituation and appearance of Scylla: let us now conſider the danger it occaſions to mariners. Though the tide is almoſt imperceptible in the open parts of the Mediterranean, it is very ſtrong in the ſtrait of Meſſina, in conſequence of the narrowneſs of the channel,

channel, and is regulated, as in other places, by the periodical elevations and depreſſion of the water. Where the flow or current is accompanied by a wind blowing the ſame way, veſſels have nothing to fear, ſince they either do not enter the ſtrait, both the wind and the ſtream oppoſing them, but caſt anchor at the entrance; or, if both are favourable, enter on full ſail, and paſs through with ſuch rapidity that they ſeem to fly over the water. But when the current runs from ſouth to north, and the north wind blows hard at the ſame time, the ſhip which expected eaſily to paſs the ſtrait with the wind in its ſtern, on its entering the channel is reſiſted by the oppoſite current, and, impelled by two forces in contrary directions, is at length daſhed on the rock of Scylla, or driven on the neighbouring ſands; unleſs the pilot ſhall apply for the ſuccour neceſſary for his preſervation. For, to give aſſiſtance in caſe of ſuch accidents, four-and-twenty of the ſtrongeſt, boldeſt and moſt experienced ſailors, well acquainted with the place, are ſtationed night and day along the ſhore of Meſſina; who, at the report of guns fired as ſignals of diſtreſs from any veſſel, haſten to its aſſiſtance, and tow it with one of their light boats. The current, where it is ſtrongeſt, does not extend over the whole ſtrait, but winds through it in intricate meanders, with the courſe of which theſe men are perfectly acquainted, and are thus able to guide the ſhip in ſuch a manner as to avoid it. Should the pilot, however, confiding in his own ſkill, contemn or neglect this aſſiſtance, however great his ability or experience, he would run the moſt imminent riſk of being ſhipwrecked. In this agitation and conflict of the waters, forced one way by the current, and driven in a contrary direction by the wind, it is uſeleſs to throw the line to diſcover the depth of the bottom, the violence of the current frequently carrying the lead almoſt on the ſurface of the water. The ſtrongeſt cables, though ſome feet in circumference, break like ſmall cords. Should two or three anchors be thrown out, the bottom is ſo rocky that they either take no hold, or, if they ſhould, are ſoon looſened by the violence of the waves. Every expedient afforded by the art of navigation, though it might ſucceed in ſaving a ſhip in other parts of the Mediterranean, or even the tremendous ocean, is uſeleſs here. The only means of avoiding being daſhed againſt the rocks or driven upon the ſands in the midſt of this furious conteſt of the winds and waves, is to have recourſe to the ſkill and courage of theſe Meſſineſe ſeamen.

In proof of the truth of this aſſertion, I might adduce many inſtances related to me by perſons deſerving of credit. But I was myſelf an eye-witneſs to the ſituation of a trading veſſel from Marſeilles, which had one day entered the Strait by the mouth on the north ſide, at the time that I was on a hill looking towards the ſea. The current, and a north wind which then blew ſtrong, being both in its favour, the veſſel proceeded under full ſail into, and had paſſed one half of the Strait, when, on a ſudden, the ſky became overcaſt with thick clouds, and violent guſts of wind aroſe, which in an inſtant changed the direction of the current, and turned up the ſea from its bottom. The mariners had ſcarcely time to hand the ſails, while the furious waves broke over the ſhip on every ſide. Whether they merely followed the practice uſual with ſhips in diſtreſs, or whether they were acquainted with the laudable cuſtom of the Meſſineſe, I cannot ſay; but they fired two guns; immediately upon which one of the barks employed on this ſervice haſtened to the aſſiſtance of the diſtreſſed veſſel, and, taking it in tow, began to make every exertion to carry it ſafely into the harbour.

If I had ſeen with fear and ſhuddering the danger of the ſailors on board the veſſel, which

which I expected every moment would be fwallowed up in the waves; I beheld with wonder and pleafure the addrefs and bravery of the Meffinefe mariners, who had undertaken to fteer fafely through fo ftormy a fea the fhip entrufted to their care. They extricated it from the current, which impelled it towards deftruction; changed the helm to this fide, or to that; reefed or fet the fails, as the wind increafed, or abated; avoided the impetuous fhocks of the waves, by meeting them with the prow, or oppofing to them the fide, as either method appeared moft proper to break their violence; and by thefe and other manœuvres, which I am unable to defcribe, thefe brave mariners, amid this dreadful conflict of the fea and the wind, fucceeded in their undertaking, and brought the veffel fafe into the harbour.

But enough of Scylla:—we will now proceed to Charybdis. This is fituated, within the Strait, in that part of the fea which lies between a projection of land named *Punta Secca*, and another projection on which ftands the tower called *Lanterna*, or the light-houfe, a light being placed at its top to guide veffels which may enter the harbour by night.

On confulting the authors who have written of Charybdis, we find that they all fuppofed it to be a whirlpool. The firft who has afferted this is Homer, who has reprefented Charybdis as a monfter, which three times in a day drinks up the water, and three times vomits it forth.

——— *δια Χαρυβδις αναρροιβδει μελαν ὑδωρ,*
Τρις μεν γαρ τ᾽ανιησιν επ᾽ ἠματι, τρις δ᾽αναρροιβδει
Δεινον. Hom. Odyff. XII.

Beneath Charybdis holds her boifterous reign
'Midft roaring whirlpools, and abforbs the main;
Thrice in her gulphs the boiling feas fubfide,
Thrice in dire thunders fhe refunds the tide. Pope.

The defcription of Virgil above cited, differs from that of Homer only in placing a deep gulph below. Strabo, Ifidorus, Tzetzes, Hefychius, Didymus, Euftathius, &c. repeat the fame. The Count de Buffon adopts the idea of Homer in full confidence, and places Charybdis among the moft celebrated whirlpools of the fea. "Charybdis, in the ftrait of Meffina, abforbs and rejects the water three times in twenty-four hours*." Strabo tells us, that the fragments of fhips fwallowed up in this whirlpool are carried by the current to the fhore of Tauromenium (the prefent Taormina) thirty miles diftant from Charybdis†. In confirmation of this tradition, an amufing though tragical anecdote is related of one Colas, a Meffinean diver, who, from being able to remain a long time under water, had acquired the furname of *Pefce* (the fifh). It is reported that Frederic, king of Sicily, coming to Meffina purpofely to fee him, made trial of his abilities with a cruel kind of liberality, by throwing a golden cup into Charybdis, which if he brought up was to be the reward of his refolution and dexterity. The hardy diver, after having twice aftonifhed the fpectators by remaining under water a prodigious length of time, when he plunged the third time appeared no more; but, fome days after, his body was found on the coaft, near Taormina.

* Buffon, Hift. Nat. tom. ii. in 12mo.

† Καταποθεντων δε και διαλυθεντων τα ναυαγια παρασυρεται προς ηιονα της Ταυρομενιας. Lib. VI.

From

From the authorities here adduced, it is evident that Charybdis has hitherto been confidered as a real whirlpool, by both ancient and modern travellers who have given any account of it.

As I was therefore fo near to this celebrated place, I determined to endeavour to afcertain, if poffible, what it really is. It is diftant from the fhore of Meffina about feven hundred and fifty feet, and is called by the people of the country *Calofaro*, not from the agitation of the waves as fome have fuppofed, but from καλος and φαρος; that is, *the beautiful tower*, from the light-houfe erected near it for the guidance of veffels. The phenomenon of the Calofaro is obfervable when the current is defcending; for, when the current fets in from the north, the pilots call it the *defcending rema**, or current; and when it runs from the fouth, the *afcending rema*. The current afcends or defcends at the rifing or fetting of the moon, and continues for fix hours. In the interval between each afcent or defcent, there is a calm which lafts at leaft a quarter of an hour, but not longer than an hour. Afterwards, at the rifing or fetting of the moon, the current enters from the north, making various angles of incidence with the fhore, and at length reaches the Calofaro. This delay fometimes continues two hours. Sometimes it immediately falls into the Calofaro, and then experience has taught that it is a certain token of bad weather.

As I was affured by the pilots moft experienced in this practical knowledge, that there was no danger in vifiting the Calofaro, I refolved to avail myfelf of the opportunity. The bark in which I made the excurfion was managed by four expert mariners, who, perceiving me fomewhat intimidated as I approached the place, encouraged me, and affured me they would give me a very near view of the Calofaro, and even carry me into it without the leaft danger.

When I obferved Charybdis from the fhore, it appeared like a group of tumultuous waters; which group, as I approached, became more extenfive and more agitated. I was carried to the edge, where I ftopped fome time to make the requifite obfervations, and was then convinced beyond the fhadow of a doubt, that what I faw was by no means a vortex, or whirlpool.

Hydrologifts teach us, that by a whirlpool in a running water we are to underftand that circular courfe which it takes in certain circumftances; and that this courfe, or revolution, generates in the middle a hollow inverted cone, of a greater or lefs depth, the internal fides of which have a fpiral motion. But I perceived nothing of this kind in the Calofaro. Its revolving motion was circumfcribed to a circle of at moft an hundred feet in diameter; within which limits there was no incurvation of any kind, nor vertiginous motion, but an inceffant undulation of agitated waters which rofe, fell, beat, and dafhed on each other. Yet thefe irregular motions were fo far placid, that nothing was to be feared in paffing over the fpot, which I did; though our little bark rocked very much from the continual agitation, fo that we were obliged conftantly to make ufe of our oars to prevent its being driven out of the Calofaro. I threw fubftances of different kinds into the ftream. Such as were fpecifically heavier than the water funk, and appeared no more; thofe which

* I have obferved that at Meffina, as well as in other parts of Sicily, words of the Greek language, which was once that of this ifland, are ftill retained. Thus the word *rema* derived from ῥευμα, a flowing, or ftream, is ufed to fignify the current of this ftrait.

were lighter remained on the furface, but were foon driven out of the revolving circle by the agitation of the water.

Though from thefe obfervations I was convinced that there was no gulph under the Calofaro; as otherwife there would have been a whirlpool, which would have carried down into it the floating fubftances; I determined to found the bottom with the plummet, and found its greateft depth did not exceed five hundred feet. I was likewife informed, to my no fmall furprife, that beyond the Calofaro, towards the middle of the ftrait, the depth was double.

I could not therefore but conclude from thefe facts, that at that time there was no whirlpool in Charybdis. I fay *at that time*, fince the cafe might be very different when the fea was tempeftuous. I therefore made enquiry relative to this of the pilots, thofe, efpecially, who, from their tried experience, were appointed by the public to give affiftance in ftorms to foreign veffels, and who had frequently feen Charybdis in its greateft fury. The following is the fubftance of the anfwers they gave me:

When the current and the wind are contrary to each other, and both in their greateft violence, efpecially when the fcilocco, or fouth wind, blows; the fwelling and dafhing of the waves within the Calofaro is much ftronger, more impetuous, and more extenfive. It then contains three or four fmall whirlpools, or even more, according to the greatnefs of its extent and violence. If, at this time, fmall veffels are driven into the Calofaro by the current, or the wind, they are feen to whirl round, rock, and plunge; but are never drawn down into the vortex. They only fink when filled with water, by the waves beating over them. When veffels of a larger fize are forced into it, whatever wind they have they cannot extricate themfelves; their fails are ufelefs; and after having been for fome time toffed about by the waves, if they are not affifted by the pilots of the country, who know how to bring them out of the courfe of the current, they are furioufly driven upon the neighbouring fhore of the Lanterna, where they are wrecked, and the greater part of their crews perifh in the waves*.

If we confider maturely thefe facts, we fhall find that a great part of what has been written relative to Charybdis is very erroneous. We have feen how many authors, from Homer to the prefent time, have defcribed it as a real whirlpool, or great gulph revolving in itfelf, within the circumference of which fhould any fhip enter, it is immediately drawn to the centre and fwallowed up. When the current is dying away, or when there is no current, this defcription has no refemblance to truth. Charybdis is then perfectly innocent, as I have been fully convinced by my own obfervations; and even when it is agitated

* The following account of the fhipwreck of a veffel in the Calofaro was fent me, after my return from Sicily, by the Abbate Grano from Meffina:

"About three weeks ago, we were fpectators of the finking of a Neapolitan polacca in the Calofaro, on its paffage from Puglia, laden with corn. A moft violent fouth-eafterly wind blew, and the veffel, with all fails fet, endeavoured to reach the harbour, ftanding off from the Calofaro; but the head of the current from the entrance by the faro took her, and drew her impetuoufly into it; where, without being able to make ufe of her fails, fhe remained for fome time toffed about by the waves, which at length, either breaking over her, or opening her fides by their furious beating, fent her to the bottom. The crew, however, and a part of the cargo were faved by the fpeedy affiftance given by our mariners in two fmall barks, who had the courage to encounter the danger. You will perceive from this, in what manner the waves may fink fhips in Charybdis, without the neceffity of fuppofing a whirlpool."

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and dangerous, it ftill contains no incavation, or gulph of the nature of a vortex; but merely a ftrong agitation and dafhing of its waves, which produces thofe fmall whirlings of its waters, which are only accidental and not to be feared. So far likewife is Charybdis from drawing to itfelf and fwallowing veffels, that it rather repels them, and throws them to a diftance.

* This error has arifen like many others with refpect to the productions of nature. Homer, in relating the voyage of Ulyffes through the Strait of Meffina, was the firft who defcribed Charybdis as an immenfe vortex, which abforbs and rejects the water, and the fhips that approach it; exemplifying his account by the fate of fome of the companions of his hero, who were carried away by the whirlpool. The writers who came after him, whether poets, orators, hiftorians, or geographers, have followed him in this defcription, without any one of them taking the pains to repair, to the place and examine it himfelf. Even Fazello the Sicilian, who was fo induftrious in afcertaining facts, and whofe accounts of his country are fo accurate, clearly fhews in his defcription of Charybdis, that he had never obferved it himfelf; and concludes his narration with the erroneous fuppofition above cited, that the things fwallowed up by Charybdis are conveyed by fubmarine currents to the fhores of Taormina.

Among all who have written on this fubject, we only find Cluverius who feems, at leaft at firft view, to have vifited the place. I fhall tranfcribe his words:

"Ego fane, cum Charybdis nofcendæ gratia aliquot dies Meffanæ fubfifterem, et ab hominibus ejus loci, maximè vero nautis, non Siculis modo, fed et Belgis, Britannis et Gallis, qui hoc fretum frequentes navigant, diligentius eam rem fcifcitarer, nihil omnino certi ipfis perdifcere potui, adeo fcilicet totum negotium omnibus obfcurum et incognitum erat. Tandem tamen reperi Charybdim, quæ incolis, patriis vocabulis, dicitur Calofaro, fub prædicta ad Meffanenfem portum pharo effe mare rapidè fluens, atque in vortices actum: quod non τρις επ' ἠμαλι ut tradit Homerus, id eft *fingulis diebus ter*, abforbet ingenti gurgite, revomitque aquas, fed quoties vehementiori fluctu fretum comitatur."

"I remained fome days at Meffina, with a view to obtain fome information relative to Charybdis; but though I made every enquiry of the people of the place, and principally the failors, not the Sicilian only, but the Italian, Dutch, Englifh, and French, who frequently navigate that Strait, I could learn nothing fatisfactory, fo little was known by them on the fubject. At length however I found Charybdis, which the natives call *Calofaro*, under the lighthoufe before mentioned near the harbour, to be a fea rapidly flowing, and forming vortices. It does not abforb the waters in its vaft gulph, and reject them *thrice in a day*, as Homer tells us; but as often as the fea runs high in the Strait."

From the expreffion "I found Charybdis" we might be induced to believe, that he made his obfervations on the fpot. It is certain however that he does not explicitly tell us fo: and when treating of a phenomenon, of which he was fo anxious to obtain an accurate knowledge, which he could not procure even from the Meffinefe failors, it is ftrongly to be prefumed, that he would not have fuppreffed a circumftance of that importance. As Charybdis may be feen from the fhore, if he only went thither and turned his eyes towards it, he might with truth affert that he had difcovered it. The other adjuncts to his account, that Charybdis is a rapid fea, and that it abforbs and rejects the water in

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a ſtorm, convince me that he had not a juſt idea of it, but ſatisfied himſelf with the old tradition concerning Charybdis.

It may be obſerved, that the ſituation of Charybdis, as it has been hitherto deſcribed, does not exactly agree with that aſſigned it by Homer. Let us refer to the poet. The goddeſs Circe gives the following directions to Ulyſſes, with reſpect to the navigation of the Strait of Meſſina:

> Ὁι δε δυω σκοπελοι, ὁ μεν ουρανον ευρυν ικανει . . .
> Τον δ' ἑτερον σκοπελον χθαμαλωτερον οψει Οδυσσευ,
> Πλησιον αλληλων, και κεν διοιϛευσειας.
> Τῳ δ' εν ερινεος εστι μεγας φυλλοισι τεθηλως,
> Τῳ δ' ὑπο δια Χαρυϐδις αναρροιϐδει μελαν ὑδωρ. Hom. Odyſſ. XII.

> High o'er the main two rocks exalt their brow . . .
> Cloſe by, a rock of leſs enormous height
> Breaks the wild waves, and forms a dangerous ſtreight;
> Full on its crown a fig's green branches riſe,
> And ſhoot a leafy foreſt to the ſkies:
> Beneath, Charybdis holds her boiſterous reign
> 'Midſt roaring whirlpools, and abſorbs the main. Pope.

The firſt of the rocks here mentioned by Homer is Scylla, which he deſcribes at length; and near the other, according to this poet, Charybdis is ſituated. The diſtance from one of theſe rocks to the other is an arrow's flight, *και κεν διοιϛευσειας*, which does not at all accord with the preſent ſituation of Scylla. How are we to explain this diſagreement? Shall we ſay that Homer, availing himſelf of the licence in which poets are indulged, has ſpoken hyperbolically? I know not whether the connoiſſeurs in poetry will permit ſuch a licence. Or ſhall we ſuppoſe that Charybdis was once much nearer to Scylla; but that in a long ſeries of ages it has changed its place, and removed under Meſſina? Such a ſuggeſtion might, perhaps, be favourably received, if in remote times any conſiderable change had taken place in the Strait: but we know not of any; and it is not probable, that a change ſo remarkable as the removal of Charybdis from its place would have been paſſed over in ſilence by Sicilian writers. Within the preſent century, it is true, this Strait, of which ſo much has been ſaid, has become narrower; but at the ſame time we know, that long before this event Charybdis was ſituated where it is at preſent. The ancient and uninterrupted tradition of the Meſſineſe reſpecting this fact is confirmed by the authority of the moſt celebrated Italian, Latin, and Greek writers. Fazello tells us, "Charybdis ex parte Siciliæ paulo ſupra Meſſanam." "Charybdis is ſituated on the ſide of Sicily, a little beyond Meſſina."—Ovid ſays,

> "Hinc ego dum muter, vel me Zanclæa Charybdis
> "Devoret!"

> "Let dire Charybdis in Zanclæan ſeas,
> "Devour me if I change!"

And it is well known that Zancle was the ancient name of Meſſana, now Meſſina. Tzetzes in Lycophron ſays, Ἡ Χαρυϐδις περι Μεσηνην εϛι. "Charybdis is ſituated near Meſſina."

ſina." Strabo likewiſe, after having mentioned Meſſina, proceeds, Δεικνυται και Χαρυβδις, μικρον προ της πολεως, εν τω πορθμω. "Charybdis is ſeen in the ſtrait a little before we reach the city." Several other writers might be cited to the ſame purpoſe.

From all theſe reaſons and hiſtorical teſtimonies we muſt then conclude that Homer was not exact with reſpect to the ſituation of Charybdis; nor can it be a great offence to ſay, that in this paſſage of his long poem he has certainly nodded. The accuracy of ſeveral of his deſcriptions of various places in Sicily cannot be denied. It is ſuch that we muſt either ſuppoſe that he had himſelf travelled in thoſe parts, as is the opinion of many; or at leaſt that he had procured very faithful and circumſtantial information from others. Of this the rocks of Scylla are an example. But, as to the ſuppoſed whirlpool of Charybdis, and its ſituation, I think we may venture to affirm he never ſaw it himſelf, and that the accounts he had received of it led him into error.

We will now enquire what foundation there is for the ſaying, which became proverbial, that "he who endeavours to avoid Charybdis daſhes upon Scylla;" and which was applied by the ancients to thoſe who, while they ſought to ſhun one evil, fell into a worſe.

On this ſubject I likewiſe made enquiries of the Meſſineſe pilots abovementioned, and to what better maſters could I apply for the elucidation of ſuch a proverb? They told me that this misfortune, though not always, yet frequently happens, unleſs proper meaſures are taken in time to prevent it. If a ſhip be extricated from the fury of Charybdis, and carried by a ſtrong ſoutherly wind along the ſtrait towards the northern entrance, it will paſs out ſafely; but ſhould it meet with a wind in a nearly oppoſite direction, it would become the ſport of both theſe winds, and, unable to advance or recede, be driven in a middle courſe between their two directions, that is to ſay, full upon the rock of Scylla, if it be not immediately aſſiſted by the pilots. They added, that in theſe hurricanes a land wind frequently riſes, which deſcends from a narrow paſs in Calabria, and increaſes the force with which the ſhip is impelled towards the rock.

Before I began to write on Scylla and Charybdis, I peruſed the greater part of the ancient authors who have written on the ſubject. I obſerve that they almoſt all repreſent theſe diſaſtrous places in the moſt gloomy and terrifying colours, as continually the ſcene of tempeſts and ſhipwrecks. Theſe terrors and this deſtruction, however, they are far from exhibiting in the preſent times, it rarely happening that any ſhips are loſt in this channel, either becauſe their pilots poſſeſs the knowledge requiſite for their preſervation, or becauſe they apply for the neceſſary aſſiſtance. Whence then ariſes this great difference between ancient times and the preſent? Can we ſuppoſe that Scylla and Charybdis have changed their nature, and become leſs dangerous? With reſpect to the former, we have ſeen that this hypotheſis is contradicted by fact; Scylla ſtill remaining ſuch as it was in the time of Homer: and with regard to the latter, from the Strait of Meſſina becoming narrower, Charybdis muſt be at preſent more to be feared than formerly, as it is well known that an arm, channel, or ſtrait of the ſea is the more dangerous in proportion as it is narrow. I am rather of opinion that this difference ariſes from the improvement of the art of navigation, which formerly, in its infancy, dared not launch into the open ſea, but only creep along the ſhore, as if holding it with its hand.

Alter

Alter remus aquas, alter tibi radat arenas,
Tutus eris; medio maxima turba mari.

PROPERT. Lib. III.

To ſhun the dangers of the ocean, ſweep
The ſands with one oar, and with one the deep.

But time, ſtudy, and experience have rendered her more mature, better informed, and more courageous; ſo that ſhe can now paſs the wideſt ſeas, brave the moſt violent tempeſts, and laugh at the fears of her childhood.

To exemplify and ſupport the probability of this opinion, it will not be neceſſary to recur to the early and rude ages; much more modern times will furniſh us with ſufficient proofs. That part of the Adriatic, which ſeparates Venice from Rovigno in Iſtria, is certainly not the moſt propitious ſea to navigators. The danger of being hurried in ſix hours from one ſhore to the other, and there ſtranded; the frequency of violent winds which prevail there; the ſhallows and ſand-banks which break the waves and render them wild and irregular, may certainly cauſe ſome ſerious reflection in thoſe who embark to make the paſſage. So lately as the laſt century, the ſhipwrecks in this ſea were ſo numerous, and had ſo terrified the people of Rovigno, that, when any one was obliged by urgent buſineſs or any other cauſe to go to Venice, he conſidered himſelf as more likely to die than live; and, if he was the father of a family, uſed to make his will before he embarked. The Advocate Conſtantini, a native of that country, and a man of learning and ingenuity, told me when I was there, that he had read more than one of theſe teſtaments, depoſited among the public archives.

But at preſent I will not ſay it is a diverſion or pleaſure to make this paſſage, ſince, as ſtorms are not unfrequent, it is neceſſary to be cautious; but ſerious accidents rarely happen. I have myſelf three times made it without meeting with any cauſe of alarm. To what can this difference be attributed, but to the improvement of the nautical art? Beſides that the mariners of Rovigno were not then ſo expert in the management of their veſſels as at preſent; they made uſe of certain barks of ſo improper a conſtruction, as I was aſſured by the abovementioned Conſtantini, that it was impoſſible they ſhould long reſiſt the violence of the ſea. Thoſe on the contrary that have been built ſince that time, being of a broad and flat figure and very ſolid, are capable of withſtanding the moſt furious ſtorms. They are there called *bracere*, and are in great reputation in all the neighbouring countries. We here find a part of the ſea in which veſſels were formerly ſo frequently wrecked, and which could not be traverſed but at the riſk of life, now deprived of all its terrors, and rendered eaſily paſſable, merely by the improvements made in the art of navigation.

As a farther and ſtill more convincing proof that the dangers of Charybdis and Scylla, though in themſelves the ſame that they anciently were, have been diminiſhed, and the dread they inſpired removed by the rapid advances to perfection which this art has made in modern times; I ſhall adduce an example in another ſea no leſs an object of terror from tempeſts and ſhipwrecks, I mean the Cape of Good Hope, called the Stormy Cape by the firſt diſcoverer, and, by the mariners of thoſe times, the Raging Lion. How dreadful were the dangers of this place, where the two oceans deſcending down the oppo-

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site sides of Africa met and clashed together; where contending winds, whose power was greater in the boundless ocean; where mountainous waves, rocks, and whirlpools threatened inevitable destruction! What preparations, what caution were thought necessary for the ship which was to make this dangerous passage? Able pilots who had frequently made the voyage; masts and yards secured by additional ropes; a large supply of sails and cables, thicker and stronger than usual; and a double rudder, that in case one should be damaged there might be another to act. The mariners were to be fastened to their posts by strong ropes; the passengers shut down below, and the deck left clear for the crew; a number of whom stood with hatchets in their hands, ready to cut away the masts should it be necessary. The guns were stowed in the hold as ballast, and the port-holes, windows, and every kind of aperture, carefully closed. Such were the precautions taken in the last century, on doubling the Cape of Good Hope; but how few of them are now necessary to perform this voyage in perfect safety! Of this I have had the satisfaction to be certified by an English gentleman, Mr. Macpherson, with whom I had the pleasure of conversing in Pavia, in July 1790; and who had twice doubled this Cape in his voyages to India; a gentleman of great respectability for his information, for the various long voyages he has made, and the honourable employments he has held.

The facility with which this passage may now be made, is therefore the consequence of the perfection to which the art of navigation has arrived; and the same we may conclude with respect to Charybdis and Scylla, which at present have nothing terrible but the name, to those who pass them with the requisite precautions.

V.

*Instructions for refining Saltpetre by a new Process. By J. A. CHAPTAL, J. P. CHAMPY and BONJOUR *.*

THE crude saltpetre is to be beaten small with mallets, in order that the water may more easily attack every part of the mass. The saltpetre is then to be put into tubs, five or six hundred pounds in each tub. Twenty per cent. of water is to be poured into each tub, and the mixture well stirred. It must be left to macerate, or digest, until the specific gravity of the fluid ceases to augment. Six or seven hours are sufficient for this first operation, and the water acquires the density of between 25 and 35 degrees. (Sp. Gr. 1.21, and 1.306. See Philos. Journal I. 39.)

The first water must then be poured off, and a second portion of water must be poured on the same saltpetre amounting to 10 per cent.; after which the mixture must be stirred up, suffered to macerate for one hour, and the fluid drawn or poured off.

Five per cent. of water must then be poured on the saltpetre; and after stirring the whole, the fluid must be immediately drawn off.

When the water is drained from the saltpetre, the salt must be thrown into a boiler containing 50 per cent. of boiling water. When the solution is made, it will mark between 66 and 68 degrees of the hydrometer. (Sp. Gr. 1.848, and 1.898.)

* Translated from the Journal de Physique, bearing date August 1794, but lately published.

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The solution is to be poured into a proper vessel, where it deposits by cooling about two-thirds of the saltpetre originally taken. The precipitation begins in about half an hour, and terminates in between four and six hours. But as it is of importance to obtain the saltpetre in small needles, because in this form it is more easily dried, it is necessary to agitate the fluid during the whole time of the crystallization. A slight motion is communicated to this liquid mass by a kind of rake, in consequence of which the crystals are deposited in very slender needles.

In proportion as the crystals fall down, they are scraped to the borders of the vessel, whence they are taken with a skimmer, and thrown to drain in baskets placed on tressels, in such a manner that the water which passes through may either fall into the crystallizing vessel, or be received in basons placed underneath.

The saltpetre is afterwards put into wooden vessels in the form of a mill-hopper or inverted pyramid with a double bottom. The upper bottom is placed two inches above the lower on wooden ledges, and has many small perforations through which water may pass to the lower bottom, which likewise affords a passage by one single aperture. A reservoir is placed beneath. The crystallized saltpetre is washed in these vessels with 5 per cent. of water; which water is afterwards employed in the solution of saltpetre in subsequent operations.

The saltpetre, after sufficient draining, and being dried by exposure to the air upon tables for several hours, may then be employed in the manufacture of gunpowder.

But when it is required to use the saltpetre in the speedy and immediate manufacture of gunpowder, it must be dried much more strongly. This may be effected in a stove, or more simply by heating it in a flat metallic vessel. For this purpose the saltpetre is to be put into the vessel to the depth of five or six inches, and heated to 40 or 50 degrees of the thermometer (or about 135 of Fahrenheit). The saltpetre is to be stirred for two or three hours, and dried so much that, when strongly pressed in the hand, it shall acquire no consistence, nor adhere together, but resemble a very fine dry sand. This degree of dryness is not required when the powder is made by pounding.

From these circumstances we find, that two saline liquids remain after the operation, (1) the water from the washing; and (2) that from the crystallizing vessels.

We have already remarked, that the washing of the saltpetre is performed in three successive operations, in which, upon the whole, the quantity of fluid made use of amounts to 35 per cent. of the weight of the crude saltpetre. These washings are established on the principle, that cold water dissolves the muriates of soda, and the earthy nitrates and muriates, together with the colouring principle, but scarcely attacks the nitrate of potash.

The water of these three washings therefore contains the muriate of soda, the earthy salts, the colouring principle, and a small quantity of nitrate of potash, the amount of which is in proportion to that of the muriate of soda, which determines its solution.

The water of the crystallizing vessels contains a portion of the muriates of soda, and of the earthy salts which escaped the operation of washing, and a quantity of nitrate of potash, which is more considerable than that of the former solution.

The waters made use of at the end of the operation, to whiten and wash the crystals deposited in the pyramidal vessel, contain nothing but a small quantity of nitrate of potash.

These

These waters are therefore very different in their nature. The water of the washings is really a mother water. It must be collected in vessels, and treated with potash by the known processes. It must be evaporated to 66 degrees (or 1,848 sp. gr.), taking out the muriate of soda as it falls. This solution is to be saturated with 2 or 3 per cent. of potash, then suffered to settle, decanted and poured into crystallizing vessels, where 20 per cent. of water is to be added to keep the whole of the muriate of soda suspended.

The waters which are thus obtained by treatment of the mother water, may be mixed with the water of the first crystallization. From these the marine salt may be separated by simple evaporation; and the nitrate of potash, which they hold in solution, may be afterwards obtained by cooling.

The small quantity of water made use of to wash and whiten the refined saltpetre, contains nothing but the nitrate of potash: it may therefore be used in the solution of the saltpetre when taken from the tubs.

From this description it follows, that a manufactory for the speedy refining of saltpetre ought to be provided with (1) mallets or rammers for pounding the saltpetre, (2) tubs for washing, (3) a boiler for solution, (4) a crystallizing vessel of copper or lead, in which the saltpetre is to be obtained by cooling, (5) baskets to drain the crystals, (6) a wooden case or hopper for the last washing and draining the saltpetre, (7) scales and weights for weighing, (8) hydrometers and thermometers to ascertain densities and temperatures, (9) rakes to agitate the liquor in the crystallizing vessel, (10) skimmers to take out the crystals and convey them to the baskets, (11) syphons or hand-pumps to empty the boilers.

The number and dimensions of these several articles must vary according to the quantity of saltpetre intended to be refined.

If it be proposed to refine ten thousand weight of crude saltpetre per day, the requisite men and utensils may be determined as follows:

Part of the ground near the magazine may be disposed for conveniently breaking and pounding the saltpetre.

This ground should be paved with large flat stones very uniformly, or with thick pieces of wood. Mallets similar to those used in pulverizing gypsum may be applied to this use. Two men are sufficient to weigh and pound the saltpetre, and stow it in the magazine.

As the three washings require two days, and each tub can hold only five or six hundred pounds of saltpetre, it would require twenty days to refine ten thousand weight (with one tub).

These tubs are two feet and a half in height, and the same in diameter. They must be very well made, in order that the water of the washing may not leak out. They are to be placed solidly on a plane slightly inclined, of such a material as shall not imbibe the water which may be spilt during the operation, but transmit it to a reservoir placed at the extremity of the row of tubs.

Twenty of these tubs must be disposed in two parallel lines; the planes on which they are set may incline towards each other, and form, by their union, the gutter or cavity for transmitting into the common reservoir such waters as may escape. These tubs are perforated at the distance of two inches from the bottom. The aperture is closed by a spigot.

Four men may be appropriated to the washing of the saltpetre. It is a part of their duty to convey the saltpetre from the magazine to the tubs, and from the tubs to the boiler.

It is scarcely necessary to observe that the tubs must stand sufficiently apart, and be so disposed that the work may be easy and convenient.

A boiler of a conical form, five feet wide and four deep, will serve for three operations per day, and consequently to refine fifteen thousand weight. A single man is sufficient to attend the boiler.

The vessel for crystallization is of lead or copper, and must be as near the boiler as possible. Its depth is fifteen inches, its length ten feet, and its width eight. It must be placed on a very solid support, so that its bottom may every where rest upon it. It is convenient to raise this support of masonry about twelve inches above the ground. By this means the borders of the crystallizing vessel will be 27 inches above the floor, which will render the operation easy and convenient.

It has appeared to us of advantage to give to the bottom of the crystallizing vessel, an inclination of four inches from the sides to the middle, merely in the longitudinal direction. The solutions may be emptied for several successive times from the boilers into the crystallizing vessel, after having taken out the crystals deposited from each solution.

Four men appear necessary for the operation of the crystallizing vessel. Their business is to agitate the fluid continually with the rakes. They collect without intermission on the borders of the vessel the crystals which fall down, and convey them with a skimmer to the baskets prepared for their reception and draining. These same workmen put the saltpetre into the wooden vessel for the last washing and drainage, and carry the refined saltpetre into the magazine.

For want of a large cooler for crystallization a shallow boiler may be used, or the same vessels which serve for crystallization in the present works for refining this salt.

To prepare the saltpetre for the manufacture of gunpowder, it may be dried, after refining, by two processes, (1) by exposing it to the open air, or the sun, for several hours, upon tables; or (2) by exposing it in a shallow metallic vessel for two hours, to the heat of 40 or 50 degrees (about 135 Fahrenheit). In either case it must be agitated and stirred with scarcely any interruption, in order to dry it speedily and equally.

Considerable experience has shewn us, that the process here described is the most simple and economical. But, to prevent others from trying such methods as might seem promising, though we have thought fit to reject them, it will be proper to offer the following remarks:

1. Trial has been made to dissolve the saltpetre, crystallize it, and then wash it to separate the sea-salt.

This process appears most advantageous at first sight, because it saves the pounding; but it has great inconveniences. 1. Crude saltpetre dissolved in 50 per cent. of water, and poured into the vessel for crystallization, does not deposit the same quantity of saltpetre as it would do if washed before the solution. This difference depends on the muriate of soda in the crude saltpetre, which facilitates the solution of the nitrate of potash, and consequently the water of the crystallizing vessels must retain in solution more nitrate of potash, when the crude saltpetre is dissolved, than when it has been previously washed with cold

cold water, and deprived of the marine salt which it contains. 2. The washing of saltpetre, when it is performed after the solution and crystallization, requires 40 or 50 per cent. of water instead of 35.

3. Trial has been made to dissolve saltpetre in 20 or 25 per cent. of boiling water; to take out the sea-salt in proportion as it falls by the ebullition of the liquor; to dilute the fluid with 30 per cent. of additional water, and then to convey it into the vessel of crystallization. It was expected that the washings with cold water might be avoided, or considerably diminished by these means; but, not to mention that ebullition maintained for four or five hours to separate the sea-salt supposes very great consumption of time, fuel, and saltpetre, the washings are still indispensable to remove the colouring principle, and to carry off the last portions of muriate of soda.

4. It may be thought that the quantity of water in the washings might probably be diminished; but there is reason to fear that when the saltpetre is loaded with sea-salt, it cannot be perfectly refined by the use of a less quantity of water than we have prescribed.

5. The operator may also be tempted to diminish the proportion of water employed in the solution; but we are convinced by numerous experiments, that this proportion is the most suitable. If it be increased, the saltpetre remains dissolved in the fluid; if it be diminished, it settles or falls down in a solid mass. Observation has proved, that the degree of saturation best adapted to this work, is between the 66th and 68th degrees of the hydrometer (sp. gr. 1.848, and 1.896.)

6. It may likewise be thought more simple and economical to treat the solution of crude saltpetre with potash. But it is to be feared in this case that part of the alkali might be employed in decomposing the muriate of soda, to convert it into muriate of potash; and it must be observed, that this last salt is not at all proper to decompose the earthy nitrates, notwithstanding the assertions of skilful chemists to that effect.

It appears, therefore, more convenient to defer the treatment of the mother waters, and not to use potash till after the sea-salt has been separated by evaporation.

This process, therefore, unites a number of advantages.

1. It consumes much less fuel: for, instead of two long solutions and ebullitions, nothing more is required than to give the water a boiling heat in order to dissolve the saltpetre.

2. It requires less time. Three days are sufficient to purify the saltpetre to the degree suitable for making gunpowder.

3. It disposes the saltpetre to dry more readily. As the crystals are no larger than small needles, a few hours' exposure to the air are sufficient for its complete desiccation. This advantage is inestimable, particularly in a season wherein several months would be required to drain the large loaves of nitre; and in which, consequently, the fabrication of gunpowder would be either retarded or suspended, and the drying-houses encumbered with quantities of humid nitre.

4. It requires less space. A boiler five feet in diameter and four in depth, a vessel for crystallization of a few feet dimensions, and thirty tubs, are perfectly sufficient to refine fifteen thousand weight daily.

5. It occasions less loss. Very accurate experiments have shown that the solutions used in the ancient process occasioned a loss of saltpetre, by mere evaporation, which amounted to 7 per cent. of the original quantity. By this new process, the water which holds the salt-

petre in ſolution is never heated to boiling, the ſalt does not remain in the boiler, and the evaporation is almoſt nothing.

VI.

On the Light emitted by Superſaturated Borate of Soda, or Common Borax. By Mr. F. Accum.

To Mr. Nicholson.

SIR,

THAT two flints and ſeveral other ſiliceous ſtones, ſtruck againſt each other, appear luminous on the ſide ſtruck upon; and that phoſphate of lime, tremolite, ſugar, gum elemi, black jack, and various reſins become luminous, and emit phoſphoric ſparks in the dark, when ſcratched with a ſharp inſtrument, or ſtruck againſt one another, are well known to every tyro of natural philoſophy; but that *ſuperſaturated borate of ſoda* poſſeſſes this property in the higheſt degree, has not perhaps been hitherto remarked. Two pieces of this ſalt, of conſiderable magnitude, ſtruck againſt another, or a ſwift blow with any ſharp inſtrument upon it, produces ſuch a flaſh of white light, as none of the before-mentioned ſubſtances are capable of giving. It deſerves therefore a place under the claſs of thoſe kinds of phoſphoric ſubſtances which give a perceptible light by attrition or percuſſion, without having been expoſed either to the ſolar or artificial light; for which reaſon I take the liberty of laying this before you, begging you will give theſe lines a place in your much-admired Journal of Natural Philoſophy.

I remain, Sir, your very humble ſervant,

Hay-Market, No. 17. FREDERICK ACCUM.

VII.

New Conſtruction of the Air Pump. By Sir George S. Mackenzie, Bart.

FIG. I. plate 1, repreſents a ſection of the barrel. C is a cup for oil to moiſten the collar of leathers L, in which the piſton rod R works. φ is a plug—P P P P is the piſton, which is ſolid, except a ſpace for a collar of leathers λ, through which the wire W attached to the valve V, paſſes into a perforation in the piſton rod. N is a ſmall nut to prevent the valve from riſing too high. This method of lifting the valve was invented many years ago by Dr. Rutherford of Edinburgh. X is a perforation in the ſide of the bottom of the barrel, into which is inſerted a piece of metal, as in fig. 5, with a ſilk valve tied over it, opening downwards into the pipe K. E is the pipe leading to the receiver.

The conſtruction of the bottom of the barrel is ſeen in fig. 2 and 3. Fig. 4 is the valve and wire. Fig. 5 ſhews the conſtruction of the pipe E leading to the receiver, which is better than bent copper tubes, as theſe are apt to crack. Fig. 6 is caſt ſolid and bored.

Fig.

Fig. 7 is the cap ſcrew by which the pipes are fixed. Fig. 8 is the pipe uſed for the condenſing apparatus.

That this pump may work well, it is neceſſary that the bottom of the piſton be perfectly fluſh with the bottom of the barrel.—The method of operation is as follows:

When the piſton is to be raiſed, let the plug φ be opened.—The piſton riſing, expels the air above it through φ. When the piſton is at the higheſt, ſhut the plug. There will now be no preſſure above the piſton, which will greatly facilitate the working. As the piſton riſes, the friction of the collar of leathers λ will raiſe the valve V, and the air in the receiver through the communication E will expand itſelf into the barrel. When the piſton is depreſſed, V ſhuts, and the air is expelled through K, to which a pipe as fig. 8 may be attached for condenſation. When the piſton reaches the bottom, no air will be left in the barrel, except the very ſmall quantity in the very ſmall hole of the valve X, which is very little when compared to the capacity of the barrel. By proceeding in this manner, a very perfect vacuum will be formed in the receiver.—By taking off the receiver and applying the pipe fig. 8, and attaching it to any veſſel, and opening the plug φ, we have a complete condenſing apparatus. If required, the air may be taken from the receiver and thrown into another veſſel. Moiſtened leather ought not to be uſed for fixing the receiver, as vapours are conſtantly iſſuing from it; a drying lute is better.

This air pump may be made of a much cheaper conſtruction than that of the plate, which, however, is the more convenient.

In the obliging letter which accompanied this communication, the author aſſures me, that its ſimplicity and convenience have been found conſiderable by experience. The reader will perceive, by turning to the firſt volume of our Journal, p. 128, that the happy contrivance of the wire for lifting the lower valve is alſo claimed by Cuthbertſon, who in his pamphlet*, page 6, informs us that the hint of ſuch an apparatus was firſt given to him by M. Paets van Trooſtwyk. It is not ſaid that Dr. Rutherford carried his invention into practice. This merit is due to Mr. Cuthbertſon and Sir G. M. I remember the ſame ingenious thought having been alſo ſtated by another philoſophical gentleman, in 1783, when the air pump of Haas† was much talked of.

The air pump of Sir George Mackenzie differs in effect from that of Mr. Cuthbertſon in the ſolidity of the piſton, and in not having an oil veſſel to the valve through which the air is extruded. The air pump of Sir George will ceaſe to exhauſt, ſuppoſing every thing elſe perfect, when the maſs of air in the receiver bears the ſame proportion to an equal volume of external air, as the capacity of the bore of the valve-piece X, bears to the interior capacity of the barrel when the piſton is up. Cuthbertſon's pump will have a ſimilar limit with relation to the communication pipe as to the upper valve (Philoſ. Journal, pl. 7, vol. 1, fig. 1.) and the capacity of the barrel above the piſton when down. In Prince's air pump, and in the project mentioned at p. 131 of the ſame volume; if the

* Deſcription of an improved Air Pump, &c. by John Cuthbertſon, London; ſold by Johnſon. No date, but, as I think, publiſhed ſeven or eight years ago.

† Phil. Tranſ. M,DCC,LXXIII.

valves

valves be made to open mechanically, the maximum of exhauftion will in theory be in the duplicate ratio of the fmaller fpace to the larger, affuming both ftrokes to be equal in the barrels through which the air fucceffively paffes. And in Sadler's pump with oil (Ibid. plate xix. fig. 1.) the maximum will be indefinitely great, becaufe every ftroke muft take out a like part of the refidue of air from the receiver.

VIII.

On the Action of Nitre upon Gold and Platina. By SMITHSON TENNANT, *Efq.* F. R. S.*

GOLD, which cannot be calcined by expofure to heat and air, has been alfo confidered as incapable of being affected by nitre. But in the courfe of fome experiments on the diamond, an account of which has been communicated to this fociety, I obferved that when nitre was heated in a tube of gold, and the diamond was not in fufficient quantity to fupply the alkali of the nitre with fixed air, a part of the gold was diffolved. From this obfervation I was induced to examine more particularly the action of nitre upon gold, as well as to enquire whether it would produce any effect upon filver and platina.

With this intention I put fome thin pieces of gold into the tube, together with nitre, and expofed them to a ftrong red heat for two or three hours. After the tube was taken from the fire, the part of the nitre which remained, confifting of cauftic alkali, and of nitre partially decompofed, weighed 140 grains; and 60 grains of the gold were found to have been diffolved. Upon the addition of water, about 50 grains of the gold were precipitated in the form of a black powder. The gold which was thus precipitated was principally in its metallic ftate, the greater portion of it being infoluble in marine acid. The remaining gold, about ten grains in weight, communicated to the alkaline folution in which it was retained, a light yellow colour. By dropping into this folution diluted vitriolic or nitrous acid, it became at firft of a deeper yellow, but, if viewed by the tranfmitted light, it foon appeared green, and afterwards blue. The alteration of the colour from yellow to blue, arifes from the gradual precipitation of the gold in its metallic form, which by the tranfmitted light is of a blue colour: though the gold is precipitated from this folution in its metallic form, yet there feems to be no doubt that, while it remains diffolved, it is entirely in the ftate of calx. Its precipitation in the metallic ftate is occafioned by the nitre contained in the folution, which, having loft part of its oxygen by heat, appears to be capable of attracting it from the calx of gold; for I found, that if the calx of gold is diffolved by being boiled in cauftic alkali, and a fufficient quantity of nitre, which has loft fome of its air by heat, is mixed with it, the gold is precipitated by an acid in its metallic ftate †.

Having

* Philofophical Tranfactions, M,DCC,XCVII.

† As the precipitation of gold in its metallic form by nitre which has loft fome of its oxygen, has not, I believe, been noticed, it may not be improper to mention fome of thofe facts relating to it which feem moft entitled to attention. Nitre, which has been heated fome time, precipitates gold in its metallic ftate from a folution in aqua regia, if it is diluted with water. If a folution of gold in nitrous acid is dropped into pure water, the calx of gold is feparated, which is of a yellow colour; but if the water contains a very fmall proportion of nitre, which has loft fome of its air by heat (as one grain in fix ounces), the gold is deprived of its oxygen and becomes blue. The alkali of the nitre does not affift in producing this effect. Nitrous acid alone, which

does

Having found that nitre would diſſolve gold, I tried whether it would produce any effect upon platina.

It has been formerly obſerved, that the grains of platina, in the impure ſtate in which it is originally found, might, by being long heated in a crucible with nitre, be reduced to powder. Lewis, from his own experiments and thoſe of Margraff, thought that the iron only which is contained in the grains of platina was corroded by the nitre. But by heating nitre with ſome thin pieces of pure platina in a cup of the ſame metal, I found that the platina was eaſily diſſolved, the cup being much corroded, and the thin pieces entirely deſtroyed. By diſſolving the ſaline matter in water, the greater part of the platina was precipitated in the form of a brown powder. This powder, which was entirely ſoluble in marine acid, conſiſted of the calx of platina, combined with a portion of alkali, which could not be ſeparated by being boiled in water. The platina which was retained by the alkaline ſolution communicated to it a brown yellow colour. By adding an acid to it a precipitate was formed, which conſiſted of the calx of platina, of alkali, and of the acid which was employed.

Silver I found to be a little corroded by nitre: but, as its action upon that metal was very inconſiderable, it did not appear to be deſerving of a more particular examination.

IX.

An Account of certain Cauſes of Alteration injurious to the Quality of Corn, and the Means of preventing this Change. By B. G. Sage, of the ci-devant Academy of Sciences, Profeſſor of Chemiſtry and Mineralogy in the School des Mines de la Monnoie.*

In the Analyſis of Corn, which I publiſhed in 1776, I have ſhewn that when the corn no longer contains glutinous † or vegeto-animal matter, it affords flour not adapted to produce a good panary fermentation; that the bread is not white, and has a diſagreeable taſte and ſmell; that it produces an oppreſſion at the ſtomach, putrid diſorders, and the dry gangrene, like ſmutted rye. I did not at that time know the cauſe of this alteration of corn; but diſcovered it laſt year, by attending to the farming operations in the corn country of Beaucé, where I have obſerved that the method of houſing or ſtacking the corn was more ſuited to deſtroy than to preſerve it.

In fact, the ſickle has ſcarcely cut the corn before it is collected in ſheaves to form ſhocks, or larger parcels, which are immediately conveyed into the barns, where they are packed

does not contain its full proportion of oxygen, occaſions the ſame precipitation, unleſs it is very ſtrong; and if a mixture of ſuch ſtrong nitrous acid, and of a ſolution of gold in nitrous acid, is dropped into water, the gold is deprived of its oxygen, and is precipitated of a blue colour. Two cauſes contribute to produce this effect upon the addition of water. The adheſion of the calx of gold to nitrous acid is by that means weakened, and the oxygen is attracted more ſtrongly to the imperfect nitrous acid in conſequence of their attraction for water when they are united.

* Journal de Phyſ. Sep. for 1794.

† Wheat is compoſed of the cortical part called bran, ſtarch, ſaccharine matter, and the glutinous ſubſtance. The flour obtained at the mills near Paris is compoſed of 1-16th part of ſaccharine and extractive matter, 2-3ds of white fecula called ſtarch, and 1-4th part of elaſtic glutinous matter. The corn of the ſouthern countries contain more. S.

as close as possible, without attending whether the grain and the straw be dry, as well as the more aqueous herbs which are cut along with it. The consequence is, that the corn becomes heated a few hours after it is put away, and this heat is stronger and more durable the larger and the damper the mass. The heat is frequently strong enough to bake an egg, according to the account of the cultivators. For my part, I could not hold my hand in this mass, which is as capable of spontaneous combustion as stacks of hay when put together too wet.

Fire does not manifest itself so often in our barns, because the air can scarcely at all penetrate into them, by reason of the very close stowage. When I asked the farmers why they pressed the corn so much? they affirmed, that their view was to prevent its occupying a large space, and to hinder vermin from finding their way into it.

When this heat is excited in the corn newly stowed away, a smell is emitted for three weeks resembling that of fermenting beer: it seemed at first as if aromatic herbs had been boiled in the neighbourhood.

I have observed the duration of this heat for more than four months, in a barn where the quantity stowed away amounted to a cube of about 40 feet. The corn, when taken out, was rough, ruddy, and more or less decomposed; so that in the lower part of the barn the alteration and decomposition of the glutinous matter was complete, and the grain was no longer proper for vegetation *. The bread made with flour of this corn does not rise well, and, after baking, exhibits a yellowish grey colour.

The farmers of Beaucé have a prejudice that it is good for the grain to sweat and heat, which is contrary to sound reasoning: for in this case the heat is produced by fermentation, which cannot take place but by the decomposition and loss of some of the integral parts of the corn. It is accordingly found, that the saccharine and glutinous matter are more or less destroyed in proportion to the time which the corn has remained in the heated state.

If the sheaves were dry when housed, they would not heat, and the grain would be preserved in perfection. It is proper therefore to suffer them to dry in the field, and not pack them together until they have given out all their moisture. It will also be of advantage to lay them lightly together instead of pressing, in order that the circulation of the air may carry off the last portions of humidity.

Besides the preservation of the grain, another advantage would be obtained, namely, that the straw would be neither heated nor mouldy. Straw in this last state contracts a disagreeable smell, which is repulsive to cattle.

It is in one of the most fertile corn provinces of France, in which the ground is best cultivated, that a method so prejudicial to the grain is employed. The interests of humanity being the same as that of the cultivator, it is to be presumed that, when once instructed, he will change his practice. In fact his gain will be double: for he will constantly have wholesome corn, and will sell it at a higher price than such as has been heated.

As the state and quality of corn is to be judged from the nature and quantity of the glutinous matter, it is proper to describe the process for extracting it.

Take four ounces of wheat flour separated from the bran; mix it with water to form a paste. Let this be kneaded for a quarter of an hour, and afterwards washed by working it

* I think it would be proper to suffer the corn to dry in the sheaf for the purpose of affording wholesome grain; for the fermentation alters, weakens, and often destroys it.

with

with the hands under water, which is to be changed from time to time. This washing is to be continued until the last quantity of water made use of is no longer discoloured. The substance remaining in the hands is the glutinous matter of a whitish grey colour. If the corn be good, this is elastic; (that is to say, it may be drawn into long strings, which have a disposition to shrink or contract.) If the corn has begun to heat, it is short or brittle. If it has fermented, it will afford none of this glutinous matter.

X.

Description of an Apparatus for disengaging Oxygen Gas, and applying it to the best Advantage. Constructed by JAMES SADLER, *Esq. Chemist to the Admiralty.—To which are added, Observations upon the Blow-Pipe. By W. N.*

FIG. I. plate 2, represents the vertical section of a furnace. The shaded parts denote brick work. A is the ash-hole, B the grate upon which the fuel is placed, C the opening for the reception of the fuel. It is covered with a piece of fire stone, or an earthen cover, at all times except when a supply of fuel is wanted. D is the aperture leading to the chimney F; and between D and F is a chamber for the reception of a mattrass or other vessel E, to be exposed to the action of the flame. The vessel E is put in its place, or taken out, by the opening at the upper part of the chamber; and when at work, that opening is closed by two pieces of fire stone, each of which covers half the aperture, and meets the other by a perfect ground edge, having a notch that leaves a space for the neck of the vessel. Fig. II. is a ground plan of the same furnace, with the apparatus for receiving and applying the oxygen. The letters B, E, F, denote the same parts as in fig. 1. Fig. III. exhibits a vertical section of the mattrass, and other apparatus, denoted by the same letters as in fig. 2. E is the mattrass containing black oxyde of manganese. H is a refrigeratory through which the tube of communication passes. I is a receiver for condensable vapour. The elastic fluid passes through the tube at K into the receiver L, inverted in another vessel of water M; the receiver being suspended by a string passing over a pulley, which therefore admits of a variation at pleasure of the reaction for extruding the air through the blow-pipe N P. The part N of the blow-pipe is of porcelain; and a lamp O is placed beneath for the purpose of heating the air before it issues from the orifice P. The letters G, K, and Q, denote cocks to be occasionally closed when the receiving apparatus is required to be separated or removed.

The advantages of this apparatus are, first, the simplicity of the furnace, which is applicable to a variety of uses, as well as that particularly stated in this account. As the current of atmospheric air from A, through the grate to B, D, and F, does not pass above the roof of the passage D; the upper part of the fire-place towards C, where the combustion cannot reach, may be considered as a repository for fuel, upon the principle of the athanor, and might, if required, be made equally capacious. This fuel, before it arrives at the place of combustion, serves also as a cover when the actual cover is taken off to supply the consumption; besides which, there is not the least possibility of deranging or disturbing the vessels on such occasions, as is too often the case in the common air furnace. The aperture at E

affords a degree of convenience, equally obvious, with regard to the putting in, placing, and taking out the veffels. Of the refrigeratory, the receiver I, and the apparatus M L, little more need be faid than that they are conftructed in the forms which experience has fhewn to be the moft fimple and efficacious. The parts N O P exhibit an improvement which is found to be of great importance. Mr. Sadler obferved, in the courfe of his experiments, that the effect of the oxygen, when recently produced, was much greater than fome hours afterwards. There was no reafon to conclude that this difference arofe from any change in the purity of the fluid: he therefore concluded that it muft be caufed by a difference of temperature. When the cold oxygen is brought into contact with a combuftible body at a very elevated temperature, it muft be concluded, that part of the caloric difengaged at the inftant of combination muft be employed in raifing the temperature of the mafs of oxygen, and confequently that the intenfity of the combuftion will be lefs. He therefore determined to fupply this portion of caloric from another procefs of combuftion, carried on near the external furface of the tube through which the oxygen is tranfmitted. O is the lamp for that purpofe, affording a flame, which heats the tube N, and gives an elevated temperature to the oxygen before it paffes out of the fmall aperture P. The heat excited in a piece of charcoal urged by this ftream of oxygen is fo great, as to fufe the pureft fpecimens of native rock cryftal, and alfo thofe of lime. The other effects are likewife proportionally greater.

Obfervations on the Common Blow-Pipe.

CHEMISTS and mineralogifts are too well acquainted with the ufe of this inftrument, to require any long enumeration of its advantages. To behold with eafe fuch proceffes as demand much labour and time in furnaces, and cannot in this laft fituation be eafily and comfortably infpected;—to fee thefe performed in the open air in a few feconds, with all the changes of colour, ebullition, fcoriation, and the like;—to remark the nature of the vapours which fly off, and to note the precipitation of metallic fubftances from their fluxes, or the effects they produce on the feveral kinds of glafs:—thefe are a few of the advantages which have brought this inftrument into eftimation.

It is well known that the common practice of blowing with the mouth, though very ready, and requiring an inftrument of inconfiderable coft, is not fo advantageous as the extrufion of air by means of bellows, or other mechanical contrivances. The air exhaled from the lungs has already been deprived of part of its oxygen, and is loaded with humidity. The procefs of blowing, even to the moft fkilful, is attended with fome fatigue, and requires a degree of confinement of the head and one of the hands, which confiderably diminifhes the power, as well as the eafe of the operator. Bellows, at the price of two and three guineas the fet with a few additional implements, have been contrived for this purpofe. It feemed probable to me, that thefe inftruments are larger and more coftly than is requifite. To afcertain the value of this fufpicion, I made the following experiments:

A blow-pipe nearly of the figure defcribed by Bergmann, whofe internal diameter was about one fifth of an inch at the fmalleft part, was inferted through the cork of a bottle, of which the contents were $17\frac{1}{4}$ cubic inches. The cork was notched in fuch a manner that

that when the pipe was ſtuck in the neck of the bottle previouſly filled with water, the whole could be inverted without any portion running out, though, from the ſize of the notch, a ſlight agitation was ſufficient to produce that event. In this ſituation the mouth was applied to the blow-pipe, and the air ſtrongly blown into the bottle. The water immediately flowed out, that is to ſay, in eighteen ſeconds. The experiment was twice repeated, and the aperture of the nozle of the blow-pipe was $\frac{1}{20}$th of an inch. Hence it follows, that the quantity of air emitted from the blow-pipe was not quite one cubic inch in a ſecond. For it was $17\frac{1}{4}$ cubic inches in eighteen ſeconds. It will appear alſo from an eaſy calculation, that the velocity was not quite four feet in a ſecond.

The nozle uſed in the foregoing experiment was adapted to the flame of a lamp: but it was too large for the flame of the candle called a ſhort eight, which is of tallow, nine inches long, three qrs. inch in diameter, having ſixteen yarns of cotton in its wick, and weighing $\frac{1}{8}$th part of a pound avoirdupois. The experiments were repeated with a nozle well ſuited to the flame of this candle. The aperture of this laſt was rather more than $\frac{1}{30}$th of an inch in diameter. The bottle was emptied once in 20 ſeconds, and twice with uncomfortable exertion in 18 ſeconds each time. If the velocity of emiſſion had been the ſame in both experiments, this laſt would have required about 36 ſeconds. It may therefore be inferred, that in the experiment with the largeſt aperture, the eſcape of air was ſo ſpeedy as conſiderably to diminiſh the preſſure by which it was driven out.

In order to aſcertain the condenſation of the air in the blow-pipe, a ſmall quantity of water was put into the bottle, and the blowing continued for a few ſeconds beneath the thumb, which was applied to the orifice of the neck. Air was ſuffered to eſcape at the ſame time through the lips, ſo as nearly to produce the ſame effect with regard to the muſcles of the mouth, as if the ſame had been emitted through a blow-pipe. When the action was at its utmoſt, the thumb was ſuddenly cloſed on the aperture, and the bottle inverted. In this ſituation the line of the upper ſurface of the water was carefully marked, after which the thumb was gently withdrawn, and a portion of the water flowed out in conſequence of the ſpring of the included air. By the depreſſion of the water, it was found that the air had been condenſed by about $\frac{1}{28}$th part of the whole, and conſequently would have ſuſtained a little more than an inch of mercury in a ſimple gage. It ſeemed probable, however, that the exertion of blowing into a bottle by a ſhort temporary effort, might be very different from the ſteady action of blowing through a pipe. To prove this more clearly, I bended a glaſs tube nearly of the ſame internal diameter as the blow-pipe into a ſyphon, the legs of which formed an angle of about 45 degrees of each other. Into this, mercurywas poured to occupy ſeveral inches in length, and the tube was fixed ſo that one of its legs continued vertical, while the other was acceſſible to the mouth. Upon blowing into the latter orifice, it was found that, by an eaſy or moderate action, the mercury was ſuſtained to the height of about $\frac{4}{10}$ths of an inch above its level; that when the preſſure was ſtrong, the height was about half an inch; and that it was poſſible, by very ſtrong exertion, to keep the mercury at one inch: but the lips ſoon became tired. The mercury might indeed be urged to near two inches, but not in a way that could have been maintained for even an extremely ſhort time in actual work.

From theſe facts, if we take half an inch for the medium ſtation of the gage, the preſſure

for extruding the air will anſwer to about a quarter of a pound avoirdupois upon each ſquare inch of ſurface, which is not more than an eighth part of the preſſure in the regulating belly of the blowing machines at our great foundries. I think the quantity of one cubic inch per ſecond is quite as much and probably more than iſſues out of the blow-pipe in any courſe of experiment. A pair of bellows capable of extruding ſomewhat more than two cubic inches at a ſtroke, would conſequently ſupply as much air as the pipe would deliver, provided the ſtrokes ſucceeded each other about once in two ſeconds, which appears to be a convenient rate of working, and by no means too quick. In very ſmall bellows the internal contents may be eſtimated at one third of the contents of a parallelopipedon, or ſquare box capable of circumſcribing the bellows when open. As a full allowance, let us ſuppoſe the contents of this imaginary box to be eight cubic inches, and its depth two inches. Its upper ſurface muſt then be equal to four ſuperficial inches. That is to ſay, a pair of bellows fully ſufficient to ſupply the blow-pipe will not require larger dimenſions than three inches in length, one inch and a half in width, with a lift of one inch and a half for each ſtroke. The ſame effect may be produced by a ſyringe one inch in diameter, and two inches and a half long.

The reſervoir for the air may either be another pair of bellows rather larger, and diſpoſed to ſhut by a weight or a ſpring; or it may be ſimply a veſſel of ſufficient capacity to receive the air from the bellows, and emit it in a conſtant ſtream by virtue of its ſpring under condenſation, in the ſame manner as water is emitted from the air veſſel of a fire-engine. The emiſſion of air from ſuch a veſſel may, in a looſe way, be taken to be at half the velocity of its introduction; and, conſequently, at the end of every ſtroke the veſſel will contain half as much more air, than the medium ſtate of condenſation, as amounts to the whole contents of the bellows; and at the beginning of every ſtroke, the veſſel will contain half as much leſs than that quantity. From theſe conſiderations, it appears that the ſteady ſtream from a fire-engine could not be produced but by two pumps alternately acting, and that the air anſwers ſcarcely any other purpoſe in the ſmall air-veſſels of thoſe engines, than that of rendering the intruſion of the non-elaſtic water leſs ſudden and violent. It will alſo appear from calculation, (as it does from practice, in the regulating bellies of blowing engines, on which the re-action is afforded by a variable force ſomewhat reſembling the ſpring of the air) that a very large veſſel is required to give a practical uniformity to the emitted ſtream, when the action of intruſion is not conſtant. Hence it appears, that an air veſſel cannot be uſed to advantage, unleſs the bellows to our ſmall apparatus be made double by two fixed outer boards, with valves opening inwards, and a moveable diaphragm alternating between them, and forcing the air through valves opening into one common nozle—or unleſs the ſyringe, if uſed, be made to act both ways, namely, by the returning as well as by the direct ſtroke. A very neat and compact apparatus for the blow-pipe might be made in this way; but it is probable that the conſiderations and their advantages may be more particularly applicable to the large engines at the ſmelting-works.

XI. *A ſhort*

XI.

A ſhort Account of the Life of PELLETIER. *Read at the Public Sitting of the National Inſtitute of France, the 15th Vendemiaire, in the Year VI. By* CITIZEN LASSUS, *Secretary to the Claſs of Natural Philoſophy and Mathematics.*

IN the courſe of the laſt trimeſtre we have had the misfortune to loſe one of our colleagues, Bertrand Pelletier, born at Bayonne in 1761. His life was confined to the ſhort ſpace of 36 years; but his actions have left an impreſſion on the minds of men which time ſhall not efface.

It frequently happens that young men, ſincerely deſirous of inſtruction, have no means or place where they can be aſſiſted in the development of their natural talents, no maſter who may point out the direct road to ſcience, and that order and method without which the efforts of the individual too often lead him from the object of his purſuit, inſtead of bringing him nearer to it. This was not the caſe with young Pelletier. He found every advantage in his father's houſe, where he received the firſt elements of the art of which he was afterwards the ornament; and his ſubſequent progreſs was made under our colleague Darcet, who having remarked in him that ſagacity which may be called the inſtinct of ſcience, admitted him among the pupils attached to the chemical laboratory of the college of France. Five years of conſtant application and ſtudy under ſuch a maſter, who was himſelf formed by nature, perfected by experience, and affectionately diſpoſed towards his pupil, afforded this young man a ſtock of knowledge very unuſual at his age. He ſoon gave a convincing proof of this, by publiſhing, at the age of 21, a ſet of very excellent obſervations on the arſenical acid. Macquer, by mixing nitre with the oxyde of arſenic, had diſcovered in the reſidue of this operation a ſalt ſoluble in water, ſuſceptible of cryſtallization in tetrahedral priſms, which he denominated the neutral arſenical ſalt. It is the arſeniate of potaſh. He was of opinion that no acid could decompoſe it; but Pelletier ſhowed that the ſulphuric acid diſtilled from it does diſengage the acid of arſenic. He ſhowed the true cauſe why the neutral arſenical ſalt is not decompoſable in cloſed veſſels, and particularly the order of affinity by which the ſalt itſelf is formed in the diſtillation of the nitrate of potaſh, and the white oxyde of arſenic. He explains in what reſpects this ſalt differs from what Macquer called the liver of arſenic. Pelletier had been anticipated in this work by Scheele, by Bergmann, by the academicians of Dijon, and by our colleague Berthollet; but he poſſeſſed at leaſt the merit, in the firſt eſſay of his powers, of having clearly developed all the phenomena of this operation, by retaining and even determining the quantity of gas it was capable of affording. After the ſame principles it was that he decompoſed the arſenico-ammoniacal ſalt, by ſhowing how, in the decompoſition of this laſt, the pure arſenical acid is obtained in the form of a deliqueſcent glaſs. In this work we may obſerve the ſagacity with which he was enabled to develope all the phenomena of theſe compoſitions and decompoſitions, by tracing thoſe delicate threads of ſcientific connection which connect the ſeries of facts, and are imperceptible to ordinary minds.

Encouraged by the ſucceſs of theſe firſt works, which he preſented with the ſenſibility of grateful attachment to his inſtructor, he communicated his obſervations on the cryſtallization of ſulphur, cinnabar, and the deliqueſcent ſalts; the examination of zeolites, particularly the falſe zeolite of Fribourg in Briſgaw, which he found to be merely an ore of zinc; obſervations

obſervations on the dephlogiſticated or oxygenated muriatic acid, relative to the abſorption of oxygene; on the formation of ethers, particularly the muriatic and the acetous; and ſeveral memoirs on the operation of phoſphorus made in the large way, its converſion into phoſphoric acid, and its combination with ſulphur and moſt metallic ſubſtances.

It was by his operations on that moſt aſtoniſhing production of chemiſtry, phoſphorus, that he burned himſelf ſo dangerouſly as nearly to have loſt his life. After the cure of his wound, which confined him to his bed for ſix months, he immediately began the analyſis of the various plumbagos of France, England, Germany, Spain, and America, and found means to give novelty and intereſt to his work even after the publication of Scheele on the ſame object. The analyſis of the carbonate of barytes led him to make experiments on animals, which prove that this earth is a true poiſon, whether it be adminiſtered in the form of the native carbonate of barytes, or whether it be taken from the decompoſition of the ſulphate, even though again combined with another acid.

Chemiſts have given the name of Strontian to a newly-diſcovered earth, from the name of the place where it was firſt found. Pelletier analyſed it, and diſcovered it in the ſulphate of barytes. He likewiſe analyſed the verditer of England, of which painters and paper-hangers make ſo much uſe. He diſcovered a proceſs for preparing it in the large way, by treating with lime the precipitate obtained from the decompoſition of nitrate of copper by lime. By his proceſs, verditer is afforded equal in beauty to that which comes from England. He was likewiſe one of the firſt chemiſts who ſhowed the poſſibility of refining bell metal, and ſeparating the tin. His firſt experiments were made at Paris; after which he repaired to the foundry at Romilly to verify them in the large way. The following year he was received a member of the Academy of Sciences at Paris, and ſhortly afterwards went to La Fere, with our colleague Borda and General Daboville, to aſſiſt in experiments upon a new gunpowder. Being obliged, in order to render his experiments more deciſive, to paſs great part of the day in the open air during a cold and humid ſeaſon, his health, which was naturally delicate, became conſiderably impaired. He began to recover his health, when he again became the victim of his zeal for the ſcience he ſo ſucceſsfully cultivated. He had nearly periſhed by reſpiring the oxygenated muriatic acid gas. A violent attack of convulſive aſthma, which returned during ſeveral days, was the firſt conſequence of this unhappy accident. The diſorder then ſeemed to abate, but it was incurable. The aſſiſtance of art was inſufficient to ſave him, and he died of a pulmonary conſumption in the flower of his age.

Such was the man whoſe premature loſs we now lament. His attachment for the ſcience to which he had devoted himſelf, remained during the whole of his exiſtence, and in the laſt moments of his life it formed an intereſting object of his converſation. He poſſeſſed that activity of mind ſo neceſſary to the reſearch of truths which are inacceſſible to men of cold and languid ſentiments. As a man of ſcience, his reputation is bright and unblemiſhed. As a citizen, his private virtues, his probity and good conduct will long continue objects of regret.

XII. *Extracts*

XII.

Extracts from the Syſtême du Monde of M. La Place.*

THIS work of La Place explains the leading points of the ſyſtem of the world. It is as it were an abſtract of a large work, in which this profound geometer propoſes to treat the ſame objects by the principles of the moſt ſublime geometry, and which he promiſes ſoon to publiſh. I ſhall copy ſome of the reſults of this author.

"The degree meaſured at the Cape of Good Hope in 37° ſouth latitude†, is found to be 307999,8 feet, which is very nearly the ſame as the degree of France, under the parallel of 50°, and greater than that which was meaſured in Pennſylvania, at the latitude of 43° 56, of which the length is no more than 307195,2 feet. The degree of the Cape is alſo greater than the degree meaſured in Italy in the latitude of 47° 80, which was found to be 307680,6 feet. Nevertheleſs it ought to be ſmaller than every one of theſe degrees, if the earth were a regular ſolid formed by the revolution of a meridian perfectly alike on each ſide of the equator. Every fact leads us to conclude that this is not the caſe." Vol. I. page 105.

He concludes, that the terreſtrial meridian is a line of double curvature.

"Terreſtrial bodies ſituated under the equator deſcribe, by virtue of the rotation in each ſecond of time, an arc of 40″ 1395 of the circumference of the terreſtrial equator. The radii of this equator being 19634778 feet very nearly, the verſed ſine of this arc is 0,0389704 feet. Gravitation cauſes bodies to fall at the equator through a ſpace of 11,23585 feet in one ſecond. The central force neceſſary to retain bodies at the ſurface of the earth, and conſequently the centrifugal force ariſing from its rotatory motion, is to gravity at the equator in the proportion of 1 to 288,3. The centrifugal force diminiſhes the weight, and bodies do not fall at the equator but by virtue of the difference of the true force. If we therefore uſe the word *gravity* to denote the total weight which would take place, excluſively of the diminution it undergoes, the centrifugal force at the equator is extremely near $\frac{1}{289}$th part of gravity. If the rotation of the earth were 17 times more rapid, the arc deſcribed in a ſecond at the equator would be 17 times greater, and its verſed ſine would be 289 times more conſiderable. The centrifugal force would then be equal to gravity, and bodies would ceaſe to preſs or weigh towards the earth at the equator." Page 263.

"To explain the double motion of rotation and progreſſion in the earth, it is ſufficient that the ſuppoſition be admitted of the primitive impulſe having been given at a ſmall diſtance from its centre of gravity; which diſtance, ſuppoſing the planet to be homogeneous, muſt have been nearly the $\frac{1}{160}$th part of its radius." Page 299.

"The probability is infinitely ſmall, that the original projection of the planets, ſatellites, and comets, ſhould have paſſed through their centres of gravity. All theſe bodies muſt therefore have a rotative motion. From a ſimilar reaſon, the ſun, which turns on its axis, muſt have received an impulſe, which not having paſſed through its centre of gravity, car-

* Expoſition du Syſtême du Monde, par Pierre Simon La Place, de l'Inſtitut National de France et du Bureau des Longitudes, 2 vol. in 8vo. A Paris de l'Imprimerie du Cercle Social, Rue du Théâtre François, No. 4.—I have not the work, but tranſlate from Dr. Lametherie, in the Journal de Phyſique, Auguſt 1794.

† The author divides the circle into 400 parts.

ries

ries it through space with the planetary system, unless this motion be supposed to have been destroyed by an impulse in the opposite direction; a circumstance by no means probable.

"The impulse given to an homogeneous sphere, in a direction which does not pass through its centre, will cause it to revolve constantly round the diameter, which is perpendicular to a plane passing through its centre, and the line of direction of the impressed force. New forces acting on all its parts, and of which the result passes through its centre, will not change the parallelism of its axis of rotation. Thus it is that the axis of the earth remains always nearly parallel to itself in its revolution round the sun, without its being necessary to suppose, with Copernicus, an annual motion of the poles of the earth round those of the ecliptic.

"If the body possess a certain figure, its axis of rotation may change every instant. The determination of these changes, whatever may be the forces acting on the bodies, is one of the most interesting problems of mechanics respecting hard bodies, on account of its connection with the precession of the equinoxes, and the libration of the moon. The solution of this problem has led to a curious and very useful result; namely, that in all bodies there exist three axes perpendicular to each other, round which the body may turn uniformly when not solicited by external forces. On this account these axes have been called principal axes of rotation.

"A body or system of bodies, possessing weight, and of any figure whatever, oscillating round a fixed and horizontal axis, forms a compound pendulum. No other pendulum exists in nature. The simple pendulums so frequently treated of are pure geometrical conceptions, proper to simplify the objects of discussion. It is easy to refer to these such compound pendulums as have their parts immoveably fixed together. If the length of the simple pendulum, whose oscillations are isochronous with those of the compound pendulum, be multiplied by its total mass, and by the distance of its centre of gravity from the axis of oscillation, the product will be equal to the sum of the products of each particle of the compound pendulum, multiplied by the square of its distance from the axis. It is by means of this rule, discovered by Huyghens, that experiments with compound pendulums have been applied to shew the length of the simple pendulum, which beats seconds."

The author enters into a considerable detail respecting the atmospheres of the planets. "In all the changes to which the atmosphere is subject (says he, vol. ii. p. 128.) the sum of the products of the particles of the revolving body and its atmosphere, multiplied respectively by the areas they describe round the common centre of gravity, the radii being projected on the plane of the equator, remain the same in equal times. Supposing, therefore, that, by any cause whatever, the atmosphere should become contracted, or that part thereof should become condensed on the surface of the body, the rotatory motion of the body and its atmosphere would be accelerated: for, the radii vectores of the areas described by the particles of the original atmosphere becoming smaller, the sum of the products of all the particles, by their corresponding areas, cannot remain the same unless the velocity be augmented.

"The atmosphere is flattened towards the poles, and swelled out at the equator. But this oblateness has its limits; and in the case where it is greatest, the ratio of the polar and equatorial diameter is as two to three.

"The

"The atmosphere cannot extend itself at the equator to a greater distance than to the place where the centrifugal force is exactly equal to the force of gravity. With regard to the sun, this point is remote from its centre to a distance measuring the radius of the orbit of a planet which would make its revolution in the same period as that luminary employs in its rotation. *The solar atmosphere cannot therefore extend to the orbit of Mercury*; and consequently it cannot produce the zodiacal light, which appears to extend even beyond the orbit of the earth.

"The point where the centrifugal force balances that of gravitation is nearer the body the more rapid its rotation. If we conceive the atmosphere to extend as far as this limit, and afterwards to contract and condense by cooling at the surface of the body, the motion of rotation will become more and more rapid, and the extreme limit will continually approach towards the centre. The atmosphere will therefore successively in the place of the equator abandon zones of fluid, which will continue to circulate round the body, because their centrifugal force is equal to their gravity. But as this equality does not obtain with regard to the parts of the atmosphere distant from the equator, they will not cease to appertain to the planet. It is probable that the rings of Saturn are similar zones abandoned by its atmosphere." (Vol. ii. p. 125.)

"As the motions of the planets and their satellites are performed nearly in the same plane, we must suppose one cause to have acted on all these bodies; and from the prodigious distances between them, it must have been a fluid of immense extent. To have given them in the same direction a motion, nearly circular, about the sun, it is necessary that the fluid must have surrounded that star as an atmosphere. The consideration of the planetary movements lead us therefore to think, that by virtue of an excessive heat the atmosphere of the sun was originally extended beyond the orbits of all the planets, and that it gradually contracted in process of time to its present limits. These effects may have taken place by causes similar to that which occasioned the strong light for several months in the famous star which in the year 1572 appeared all at once in the constellation of Cassiopeia.

"The great eccentricity of the orbits of the comets leads to the same result. It evidently indicates the disposition of a great number of less eccentric orbits; a circumstance which supposes an atmosphere round the sun extending beyond the perihelia of the observable comets, which, by destroying the motions of those which happened to pass within it during the time of its greatest extent, united them to the body of the sun. Hence it follows, that no other comets can at present be in existence, but such as were at that time beyond that interval. And as we cannot observe any comets but those which come near the sun in their perihelium, their orbits must be very eccentric. It also follows, that their inclinations must offer the same irregularities as if these bodies had been projected casually; because the solar atmosphere has not influenced their motions. The long time employed by the comets in their revolutions, the great eccentricity of their orbits, and the variety of their inclinations, are therefore very naturally explained by means of this atmosphere.

"But in what manner have the movements of revolution and rotation of the planets been effected? If these bodies had penetrated as such into the atmosphere of the sun, its resistance must have caused them to fall to its surface. We may therefore conjecture that they were formed at the successive limits of that atmosphere, by the condensation of the zones which it must have abandoned in the plane of its equator during its cooling and condensation at the

the ſurface of that ſtar. We may alſo conjecture, that the ſatellites have been formed in a like manner by the atmoſpheres of the planets. The five phenomena abovementioned naturally flow from theſe hypotheſes, to which the rings of Saturn afford additional probability." (Vol. ii. p. 301.)

The five phenomenaenumerated by the author are : (1) The motions of the planets in the ſame direction and nearly in the ſame plane. (2) The motions of the ſatellites in the ſame direction as the rotations of their planets. (3) The rotations of theſe different bodies and of the ſun in the ſame direction as their projectile motion, and in planes very little differing from each other ; and laſtly, (4) The eccentricity of the cometary orbits.

This great eccentricity of the comets, and their motions in all directions, appear to the author a ſufficient reaſon to conclude, that their origin is different from that of the planets. He afterwards enquires into the probability that a comet may ſtrike the globe of the earth, and deſtroy its preſent regularity of appearance, &c.

Theſe are his words, (vol. ii. p, 60.) " The fears which the appearance of comets at that time inſpired, were ſucceeded by an apprehenſion of another nature ; leſt, among the great number which traverſe the planetary ſyſtem in every direction, one of them ſhould deſtroy the earth. *They paſs ſo rapidly near us, that the effect of their attraction is not to be feared.* It is only by actually ſtriking the earth that they could produce the dreadful effect ; but the ſhock, though poſſible, is ſo very improbable in the courſe of an age ; it would require ſo extraordinary a chance for the concurrence of two bodies ſo ſmall with reſpect to the immenſity of the ſpace in which they move, that no reaſonable ground of fear can be maintained in this behalf. Nevertheleſs, the ſmall probability of ſuch an event, if it be conſidered with reſpect to a long ſeries of ages, may become very great. It is eaſy to imagine the effects of ſuch a ſhock upon the earth. The axis and rotatory motion being changed, the ſeas abandon their former poſition, and ruſh to the new equator ; great part of the men and animals drowned in this univerſal deluge, or deſtroyed by the violent ſtroke impreſſed on the terreſtrial globe ; entire ſpecies annihilated ; all the monuments of human induſtry ſwept away:—ſuch are the diſaſters which might enſue from the ſhock of a comet. We ſee therefore why the ocean has formerly covered the high mountains, on which it has left indubitable marks of its preſence ; how the plants and animals of the ſouth may have exiſted in the climates of the north, where their remains and impreſſions appear ; and laſtly, by an event of this kind, we may explain the novelty of the moral world; the regular proceſſes of which can ſcarcely be traced beyond three thouſand years. The human ſpecies reduced to a very ſmall number of individuals, and to the moſt deplorable ſtate, entirely occupied for a long ſeries of time in the care of its own preſervation, muſt have totally loſt the remembrance of the ſciences and the arts ; and when the progreſs of civilization gave efficacy to wants of leſs immediate preſſure, it became neceſſary to repeat again the various gradations of invention, as if men had then for the firſt time been placed on the earth. But however adequate the cauſe may be to theſe phenomena, for which it is aſſigned by ſome philoſophers, I repeat, that we may be perfectly at our eaſe with regard to ſo terrible an event during the ſhort interval of life individual."

XIII.

On the Preparation of concrete Acid of Lemons. By DIZÉ, *Apothecary in Chief to the French Army, charged with the Inspection of the General Magazine of Medicines* *.

THOUGH nature presents us with the citric acid nearly in a disengaged state, it is nevertheless confounded in lemon juice with an extractive mucilaginous matter, which opposes the union of its crystallizable particles, and which cannot be separated by the simple process of evaporation and exposure to crystallize.

Scheele was the first who obtained this acid in the solid form. In the year 1774, Georgius in Sweden, and afterwards Du Buisson in France, published observations on the method of concentrating and preserving lemon juice. Although their labours, as well as the experiment of Stahl and Guyton, could not determine the crystallization of this acid, it is nevertheless certain that their researches were very useful to assist Scheele in his discovery of the process he has left us.

I availed myself of an opportunity to repeat the process of Scheele in the large way, and to insist on an essential observation, which that chemist has not sufficiently developed; for it is one of the necessary conditions for success in the crystallization of this vegetable acid. Scheele, after several unfavourable attempts, advises the separation of the extractive and mucilaginous matter of lemon juice, by uniting the citric acid to the basis of calcareous carbonate, with which it forms a citrate of lime, that precipitates on account of its sparing solubility, while the extractive and mucous matter remains dissolved in the fluid. This citrate of lime is afterwards decomposed by a sufficient quantity of sulphuric acid diluted with water, with the precaution to add an excess of this last acid. The sulphuric acid seizes the lime from the citric acid, and forms a sulphate, which falls to the bottom because nearly insoluble; while the citric acid, being set at liberty, is dissolved in the water with which the sulphuric acid was diluted.

Filtration and washing with cold water separate the citric acid entirely from the sulphate of lime, and it may be afterwards obtained in the concrete state by evaporation in stoneware vessels, at the temperature of boiling water. I have observed that it is very useful to suspend the evaporation every two days, in order to permit the sulphate of lime, which is suspended by the assistance of the citric acid, to fall down.

The citric acid which I have prepared is the product of several chests of lemons. The mass of calcareous citrate which was decomposed was somewhat considerable, and the operation was performed in large stone-ware vessels. The sulphate of lime obtained by the decomposition of the calcareous citrate was well washed in tubs of white wood. The different liquors were united together for evaporation in stone-ware vessels, at the temperature of boiling water. They were clear, light-yellow, and contained an excess of sulphuric acid.

As soon as the liquors were sufficiently concentrated by evaporation, the sulphuric acid exerted its action, and the yellow colour became brown, and even blackish at the end of

* Read to the National Institute of France, and copied in the Journal de Physique, published to supply the defect of the number for September 1794.

the

the evaporation. The mafs of cryftals which was taken out, after cooling and three days repofe, was confiderable and black.

I fuffered this faline mafs to drain in ofier bafkets, while the evaporation and cryftallization of the remaining fluid were performed. When this firft operation was ended, the whole of the faline mafs was re-diffolved in a fufficient quantity of cold water, and filtered through ftrainers of linen, covered with filtering paper.

The folution which paffed the filter was clear, but of a dirty brown, and the greateft quantity of the matter which had blackened the cryftals remained behind. This was again evaporated, left to cryftallize, and in this manner exhaufted of the citric acid. The cryftals were now yellow, and more regularly figured. By a third folution, filtration, and evaporation, the cryftals were again obtained white, regular, and of the greateft purity. The black matter depofited on the filter was fo trifling that it formed a very flight covering.

Scheele, who was content with having proved the poffibility of obtaining this vegetable acid in a concrete ftate, could not determine its natural form, becaufe he operated on fuch fmall quantities.

My refults afforded cryftals as large as are ufually obtained from the ordinary proceffes of faline folution, and as eafily to be defcribed. They prefent, on fimple infpection, rhomboidal prifms, the fides of which are inclined to each other in angles of about 120 and 60 degrees, terminated at each end by four trapezoidal faces which include the folid angles.

I have before remarked, that Scheele had obferved, as one of the conditions effential to the ready cryftallization of the citric acid, to add a fmall quantity of fulphuric acid in excefs beyond the exact quantity neceffary to decompofe the calcareous citrate. The remark of this chemift not being followed by any explanation, my trials in the large way have proved the great difcernment of the chemift of Gottingen; and that, if he had operated on a quantity of lemon juice equal to that which I purified, he would have afcertained the reafons why this excefs of acid was found to be neceffary in his more confined experiments.

Having afcertained that the black matter remaining on the filters in this procefs is charcoal, it follows that it could not have been afforded but at the expence of a confiderable portion of the mucilaginous matter of the lemon juice, which the citric acid had carried with it in its combination with the bafe of the calcareous carbonate; and that afterwards when the citrate is decompofed, the excefs of fulphuric acid is required to decompofe this mucilage, and precipitate the carbone, as foon as the fluid begins to be condenfed by evaporation. The ingenious experiments of Fourcroy and Vauquelin prove the nature of the action of fulphuric acid on vegetable matter, and ftrongly confirm my inductions *.

Lemon

* For thefe important experiments fee Philof. Journal I. 385.—In order to fhew that mucilage enters into the citrate of lime, and that it is decompofed by fulphuric acid, it feems neceffary to make the experiment with only a very minute excefs of the latter. Scheele thought the acid (Effays, p. 362.) in the citrate to be pure, aud he required an excefs of fulphuric acid to be added to infure the faturation of the whole of the lime. I would propofe to the confideration of the learned author of this paper, to afcertain whether it be not a portion of the acid itfelf which is altered and made to depofit carbone. If fo, the lefs the furplus of fulphuric acid the better: but,

Lemon juice ſeparated from all the mucous matter which falls down by expoſure to the contact of the air for a few hours, that is to ſay, ſuch as it ought to be for uſe in medicine or the arts, marks five degrees of denſity by the areometer for ſalts of Baumé (ſpecific gravity 1.034). One hundred pounds of this juice require for ſaturation ſix pounds four ounces of calcareous carbonate. The citrate of lime, after being well waſhed and dried, weighs twenty pounds.

One pound of pure cryſtallized acid of lemons diſſolved in a ſufficient quantity of water, demands one pound of carbonate of lime for its ſaturation. In this experiment the weight of calcareous citrate has diminiſhed the maſs rather more than one-fourth part, inſtead of increaſing it upwards of two-thirds, as in the foregoing combination. Whence it may be concluded, that one hundred pounds of lemon juice faithfully prepared, and of the ſtrength of five degrees by Baumé's areometer for ſalts, contain ſix pounds four ounces of pure concrete acid. This ſerves to explain two phenomena; that is to ſay, the increaſe of 13lbs. 2oz. in the calcareous citrate from lemon juice, and the preſence of mucilaginous matter diſſolved in that liquid, which enters into the combination of the calcareous citrate, and is afterwards decompoſed by the exceſs of ſulphuric acid neceſſary to be added when that citrate is decompoſed.

One ounce of diſtilled water diſſolves an ounce and two drams of citric acid, and produces 13 degrees (R.) of cold by the ſolution. A like quantity of diſtilled water diſſolves twice its weight of this acid, when it is heated to 80 degrees, or the boiling temperature. One hundred parts of citric acid diſſolved in a ſufficient quantity of diſtilled water, boiling hot, diſſolve 50 parts of calcareous citrate.

A lemonade of the moſt agreeable taſte and appearance may be had by diſſolving 40 grains of citric acid in a pint of water, with the addition of a ſufficient quantity of pure ſugar. It may be rendered fragrant by diſſolving a ſmall quantity of oleo-ſaccharum, prepared by rubbing a lemon on a lump of ſugar. The ſugar imbibes the volatile oil of the lemon, and renders it ſoluble. It is eaſy by this means to preſerve the whole of the volatile oil of a number of lemons. The oleo-ſaccharum thus obtained may be mixed in a mortar with a ſufficient quantity of ſugar. The mixture is then to be dried by a gentle heat, and preſerved in well cloſed glaſs veſſels. This method of procuring the flavour of lemons at all times is preferable to employing the volatile oil obtained by diſtillation. The action of fire communicates to this laſt an acrid flavour, eaſily diſtinguiſhed by a delicate taſte.

I ſhall finiſh my obſervations by enumerating ſome of the characters of this acid, when mixed with different earthy and metallic ſolutions.

Solutions of the acetites of magneſia, lime, alumine, of the muriates of barytes, lime, alumine, and magneſia, and of the nitrates and ſulphates of theſe ſame ſubſtances, do not undergo any change by the preſence of the citric acid.

The muriates and nitrates of zinc, the ſulphate, muriate, nitrate, and acetite of copper,

but, on the other hand, if his inference be correct, the ſurplus muſt be a definite quantity, namely, ſufficient to deſtroy the mucilage. The difference of weight in the citrates formed by the crude and the purified acids with equal doſes of lime, as mentioned in a ſubſequent paragraph, may ariſe either from the preſence of mucilage in the former acid, or a change of affinity for lime produced by the re-action of the exceſs of ſulphuric acid on the latter: but experiment muſt determine which. N.

and

and the nitrate of lead, are not decomposed, but the acetite of lead is immediately decomposed and precipitated in a white powder. The nitrate and acetite of mercury are also decomposed, and the mercurial citrate which falls down is a flaky salt, of a brick-dust colour, more or less red. The citric acid gives a green tinge to the solution of the acetite and sulphate of iron.

The quantity of citric acid which I obtained being considerable, I intend hereafter to give an account of the phenomena it exhibits in its different combinations.

XIV.

Useful Notices respecting various Objects.—Governor for regulating the Motions of Steam-Engines.—Amelioration of Oil.

1. *Governor for regulating the Motions of Steam-Engines.*

THE apparatus mentioned page 424 of the present work by the name of a Governor, is there supposed to be the invention of Mr. Watt. My supposition was grounded upon no other fact than that of having seen it in his engines. It was invented by —— Bunce, Esq. of the Admiralty, who applied it to a crane several years ago, the construction of which was communicated to the Society of Arts, soon after which period it was adopted in steam-engines. I cannot now refer to the volume, as I do not possess the set. But I had the information from the inventor himself.

2. *Amelioration of Oil.*

EVERY one who has occasion to use lamps must be sensible that the colour of the light, as well as the quantity and kind of disagreeable vapour emitted from the flame, depends greatly on the quality of the oil. When oil is kept in an open vessel, it gradually becomes more and more oxygenated, and at the same time less fluid. For both these reasons it is less fit for use. It is less combustible, and less adapted to pass between the fibres of the wick. These observations point out the expediency of keeping oil in well-closed vessels. The fluidity of whale-oil, and the facility of its combustion, may be considerably augmented by an addition of cold-drawn linseed oil.

It is well known that oil may be rendered purer by agitation with water, more particularly with the addition of an acid. The effect of this process is stated to be, that it carries off a portion of mucilage, which is not adapted to answer the purposes to which oil is applied. It may easily be imagined, however, that oil thus treated will retain a portion of aqueous or saline matter, which may render it unfit to be applied to the moving parts of instruments for the purpose of diminishing friction. Some clock and watch makers expose olive-oil to the atmosphere in frosty weather; and select that portion which they find to continue fluid after a considerable part is frozen. This proceeding is grounded on the supposition, that the oil may consist of two different fluids, one of which is supposed to congeal in a less heat than the other; and that this congelation is the principal evil which happens to the oil in time-pieces. It does not seem probable that either of these suppositions are well founded.

For

For the whole of the oil will freeze, if time be allowed; and the thickening of this fluid appears to be produced by chemical change, and not by mere cooling. Mathematical inftrument-makers, directed, as I imagine, by experience only, find that oil is greatly improved by expofure to light, which it is afferted caufes it to depofit mucilage. A very exquifite regulator having the dead-beat fcapement of Graham, which requires oil on the pallets, was found to go much more fteadily when this oil was ufed, inftead of the oil commonly applied to fuch inftruments.

Moft of the facts here ftated refpecting oil were communicated to me by an intelligent cultivator of the fciences, whofe name I forbear to add becaufe I neglected to afk permiffion for that purpofe.

NEW PUBLICATION.

Reports of the late Mr. John Smeaton, F. R. S. made on various Occafions in the Courfe of his Employment as an Engineer. Printed for a Select Committee of Civil Engineers. Sold by Faden in London. Quarto. 412 pages, rather clofely printed, with a Portrait of the Author, and 2 plates.

THAT Smeaton was a man of ftrong natural powers and great induftry, that his experience and obfervations were extenfive, and his fuccefs highly to the credit of himfelf and his country, are too well known to be infifted upon. This firft volume of his Reports is publifhed at the expence of Sir J. Banks, Capt. J. Huddart, Wm. Jeffop, Robert Milne, and John Rennie, Efqrs. conditionally that the profits fhould be given to Mr. Smeaton's reprefentatives. If this liberal effort, by which the nation is benefited by fo valuable a mafs of practical information, fhould be attended with fuccefs, another volume will appear, containing the remainder of the Profeffional Reports of this great engineer. I fhall take the earlieft opportunity of communicating the general principles ufed and adopted by Smeaton, in a paper I intend to draw up refpecting the relative value and effect of firft movers, and other elementary objects of daily ufe to engineers; and in the mean time fhall avail myfelf of the Preface, nearly verbatim, to thefe Reports, to give fome account of the Society of Civil Engineers.

The origin of the Society of Civil Engineers took its rife from the following circumftances:—Before or about the year 1760, a new æra in all the arts and fciences, learned and polite, commenced in this country. Every thing which contributes to the comfort, the beauty, and the profperity of a country, moved forward in improvement fo rapidly and fo obvioufly as to mark that period with particular diftinction.

The learned Societies extended their views, their labours, and their objects of refearch. The profeffors of the polite arts affociated together for the firft time; and they now enjoy a protection favourable to improvement, and not lefs honourable to real merit than to the Public and the Throne, which have with one accord promoted their profperity.

Nor have thefe exertions failed of producing the adequate effects, comparing the prefent with the paft ftate of things.

Military and naval eftablifhments were made or enlarged, to promote and extend the true knowledge on which thefe fciences depend.

The

The navy of England fails now uncontrouled in every part of the habitable world, and her ships of war defy the combined power of all other maritime nations.

It was about the same period that manufactures were extended on a new plan, by the enterprise, the capital, and, above all, by the science of men of deep knowledge and persevering industry engaged in them.

It was perceived that it would be better for establishments to set down on new situations, best suited for raw materials and the labour of patient and retired industry, than to be plagued with the miserable little politics of corporate towns, and the wages of their extravagant workmen.

This produced a new demand, not thought of, till then, in this country—internal navigation. To make communications from factory to factory, and from warehouses to harbours, as well as to carry raw materials to and from such establishments, became absolutely necessary. Hence arose those wonderful works, not of pompous and useless magnificence, but of real utility, which are at this time carrying on to a degree of extent and magnitude to which as yet there is no appearance of limitation.

The ancient harbours of this island, it may be said, have ever been neglected, considering the increase of its naval power, and a foreign commerce of which there has never been an example in the history of mankind. The sea-ports were (I had almost said are) such as Nature formed, and Providence has bestowed upon us; and they were but little better previous to that period, notwithstanding some jettées and piers of defence ill-placed had been made and repeatedly altered, without knowledge and judgment, at *municipal*, not *government's* expence.

This general situation of things gave rise to a new profession and order of men, called Civil Engineers.

In all the polished nations of Europe, this was and is a profession of itself. Academies, or some parts of such institutions, were appropriated to the study of it, and of all the preparatory sciences and accomplishments necessary to form an able artist, whose profession comprehends the variety of objects on which he is employed, and of which the present work is an example, and a proof.

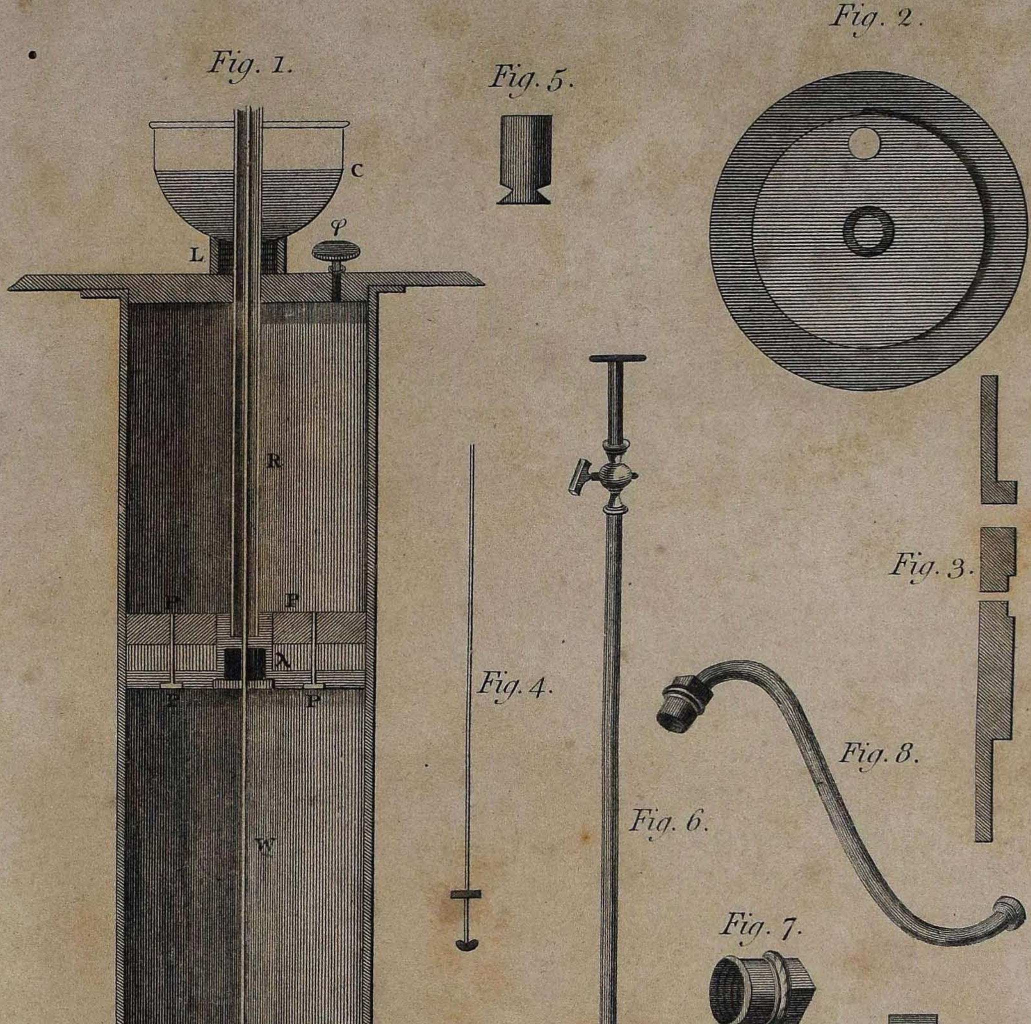
In this country, however, the formation of such artists has been left to chance; and persons leaned towards the public call of employments in this way, as their natural turn of mind took a bias. There were no public establishments, except common schools for the rudimental knowledge necessary to all arts, naval, military, mechanical, and others.

Civil Engineers are a self-created set of men, whose profession owes its origin not to power or influence, but to the best of all protection, the encouragement of a great and powerful nation; a nation become so from the industry and steadiness of its manufacturing workmen, and their superior knowledge in practical chemistry, mechanics, natural philosophy, and other useful accomplishments.

When any one who has read the varied particulars of this publication, shuts and lays it down for contemplation, he will reflect on the natural talents and sagacity requisite in that mind which applies to such a profession; on the patient application necessary to acquire all the subservient learning previous to the commencement of it; and on the wonderful and varied powers which this work exhibits.

[*To be concluded in our next.*]

Air pump by Sir G. S. Mackenzie Bart. Philos. Journal. Vol. II. Pl. I. facing p. 48.



Barlow sculp.

Apparatus for Experiments with Oxygen.

Fig. 1.

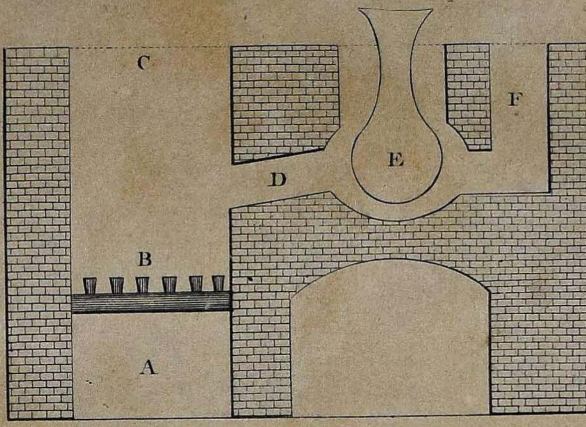


Fig. 2.

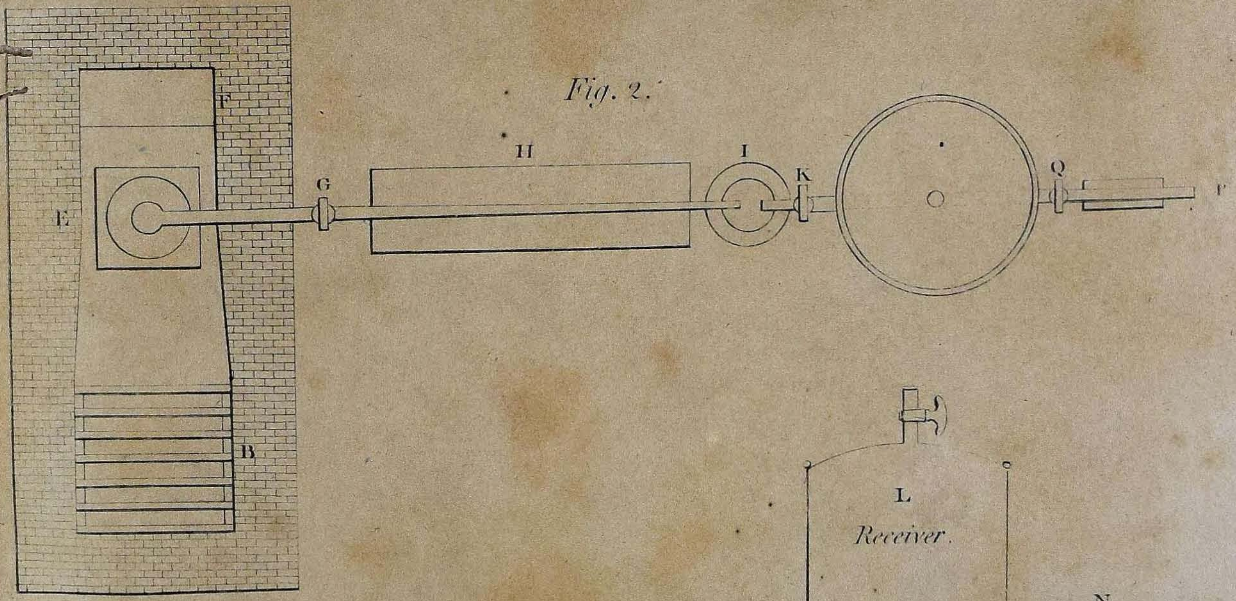
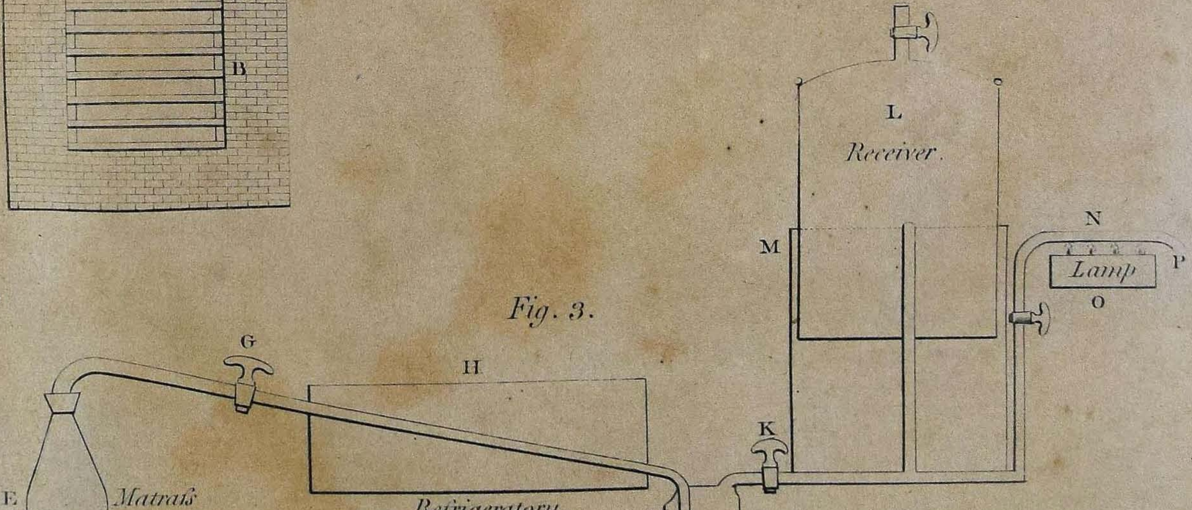


Fig. 3.



Barlow sculp.